GROWING AREA WX
Squaw Point, Stockton to Dice Head, Castine

Sanitary Survey Report

Report Date: 07-07-2014

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APPROVAL

Division Director:

_____ _____ Date: _____
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Executive Summary

This is a Sanitary Survey report for Growing Area WX which covers the Penobscot River from Squaw Point (Stockton Springs) to Dice Head (Castine) written in compliance with the requirements of the 2009 Model Ordinance and the National Shellfish Sanitation Program. No changes in classification are needed at this time. There were no new pollution sources found no new stations were added and two station WX 6 and 7 deactivated due to lack of access. Water quality has remained consistent. The next sanitary survey is due in 2025 and the next Triennial in 2016.

Growing area WX (Figure 1) is located in Hancock and Waldo Counties in the towns of Stockton Springs (pop. 1481), Prospect (pop. 642), Verona Island (pop. 533), Bucksport (pop. 4,908), Orland (pop. 2,134), Penobscot (pop. 1,344), Castine (pop. 1,343) (US Census 2000). There are about 12,960 acres of marine habitat with approximately 1,600 acres of intertidal zone along 52 miles of coastline (including Verona Island) in growing area WX. There are four licensed overboard discharges (OBD's) and one sewage treatment plant located in this growing area and at this time the entire growing area is classified prohibited. There were no new stations added or no stations deactivated during this review period.

The growing area includes the near sub-tidal waters, inter-tidal flats and at zone of shore property that extends inland to a definite up-land boundary. The shoreline included in this report stretches from Squaw Point, Stockton to Dice Head, Castine. The shoreline is typical to the convoluted shoreline of this section of Maine, with a series of shallow harbors with muddy and gravel bottoms separated by rock-bound points of land and bold shoreline. The up-land boundary of the growing area is enclosed by a line beginning at the tip of Squaw Point; then northeast to the Lighthouse-Cape Jellison; then northwest to the intersection of US Route 1-Main St, Stockton; then northeast to the paper mill in Bucksport; then east to the dam at the outlet of Alamoosook Lake; then southeast to "Five Mile Corners", Orland; and then southwest to the tip of Dice Head, Castine. Bird life includes gulls, ducks, osprey and puffins. Great numbers of rafted ducks are seen in the fall.

The largest, shallow coves are Fort Point Cove (Stockton Springs), Morse Cove (Penobscot), and Wadsworth Cove (Castine). Intertidal and subtidal areas have sand and mud with areas of grass and seaweed. Wadsworth Cove has a large population of soft shell clams (Mya arenaria), surf clams (Spisula solidissima) and evidence of razor clam shells (Ensis directus). Fort Point Cove has soft shell clams, blue mussels (Mytilus edulis) and razor clams.

Figure 1 Growing Area WX, with Active Water Stations

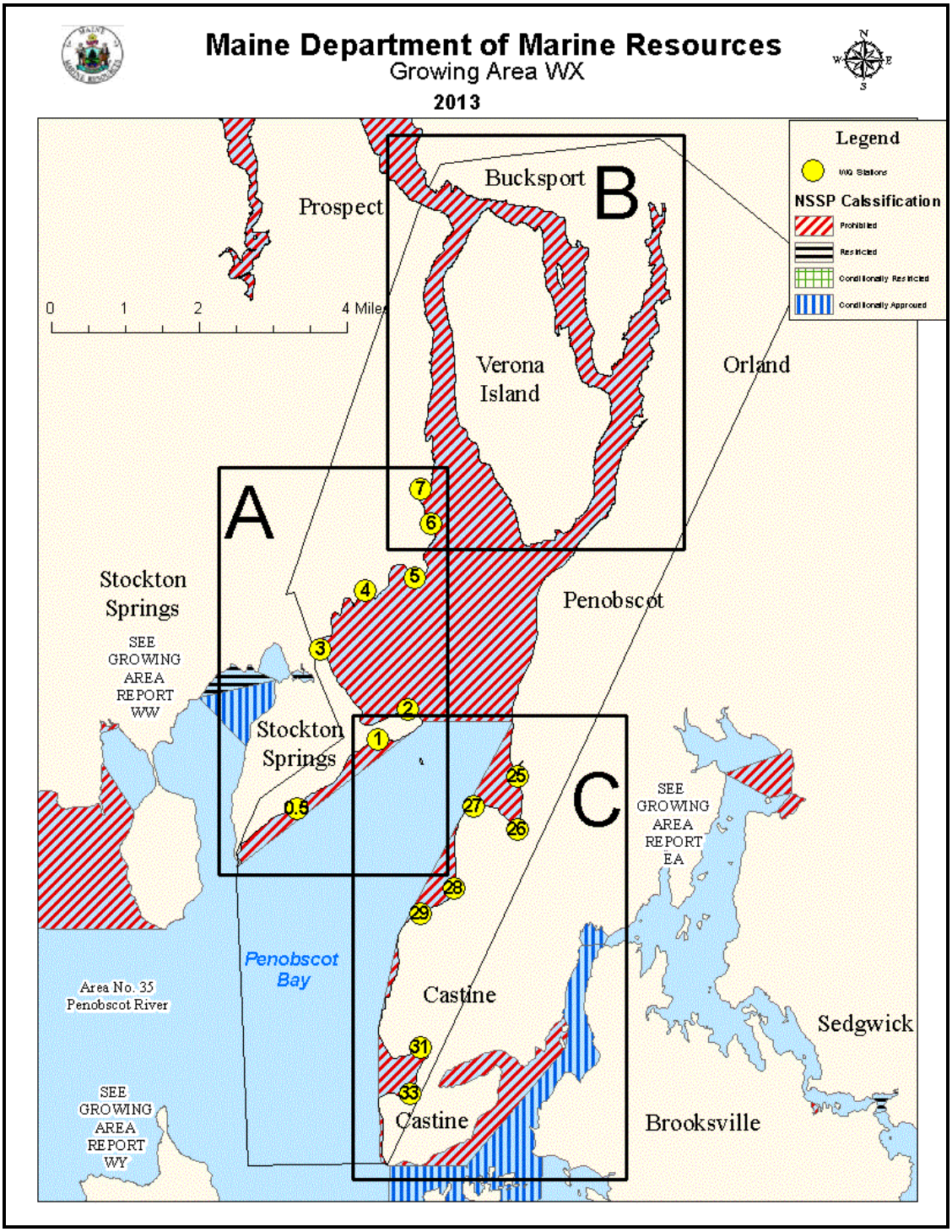


Figure 2Map A

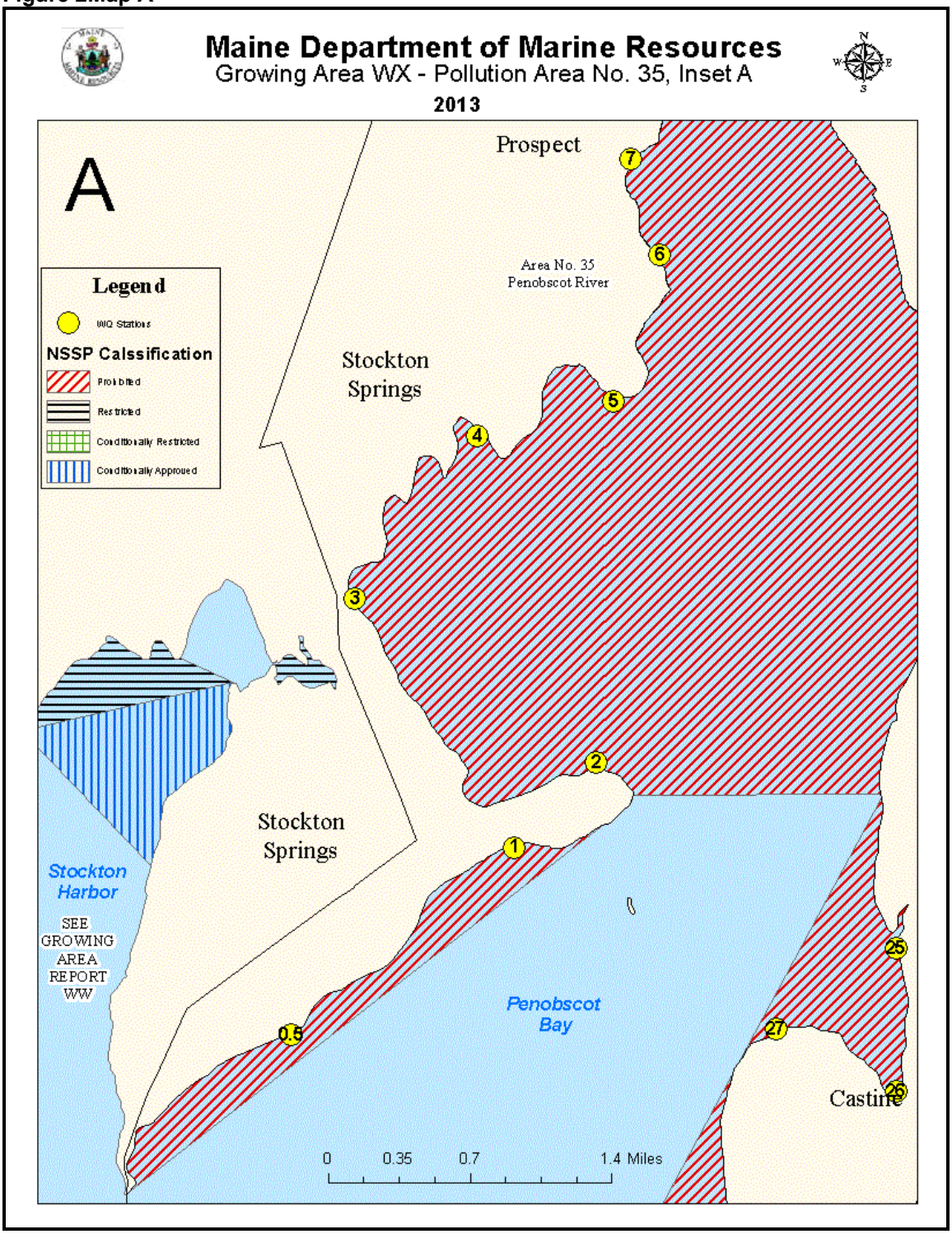


Figure 3Map B

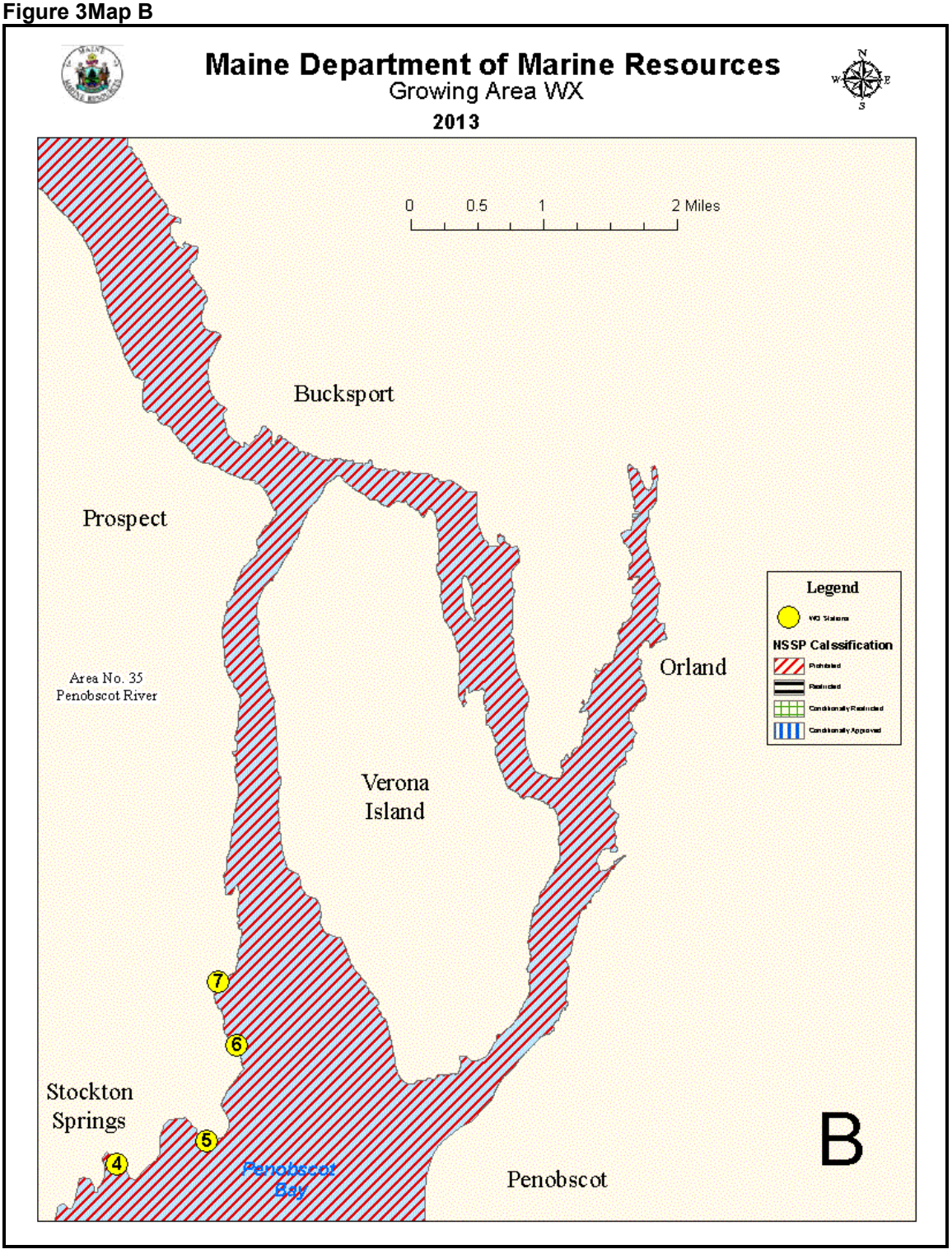
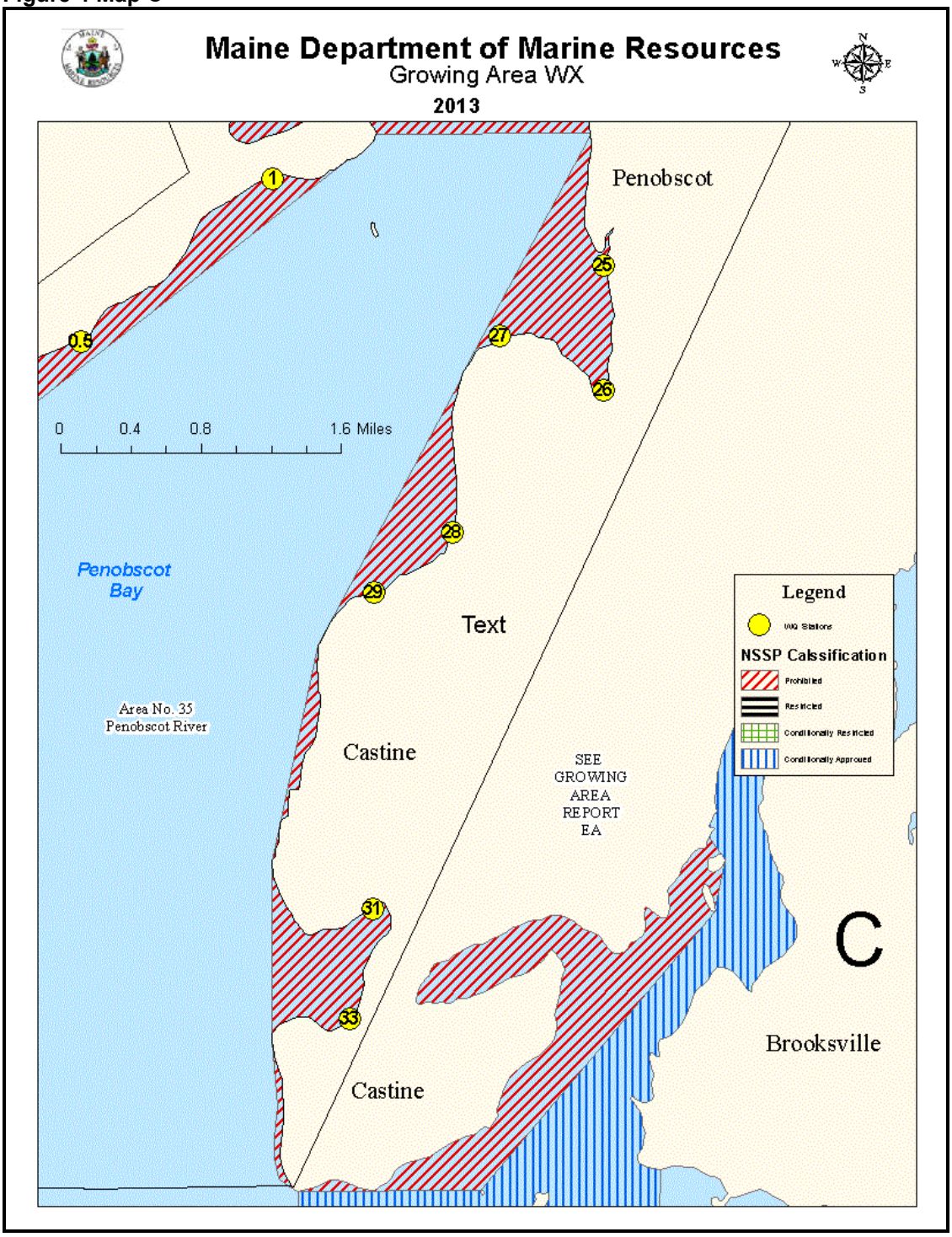


Figure 4 Map C



History of Growing Area Classification

2008: Prohibited- Area 35, Fort Point, Stockton to Morse Cove, Penobscot; (12/1/1999), Prohibited- Area 36D, Morse Cove, Penobscot to Dice Head, Castine; (2/28/2006),

2009: Area 36D and 35 were combined into Pollution Area 35 Prohibited- Area 35, Penobscot River (Stockton Springs, Prospect, Bucksport, Orland, Penobscot, Castine) (January 13, 2009).

2010: No changes.

2011: No changes.

2012: No changes.

2013: No changes.

Current Classification(s)

At the end of the 2013 review year, shellfish growing area WX had all areas classified as:

Prohibited: 12 stations: WX .5, 1, 2, 3, 4, 5, 6, 26, 28, 29, 30, and 31

Activity during Review Period

2008- 1/1/08- The towns of Winterport and Bucksport applied for a secondary treatment waiver in their NPDES permits. MeDEP issued a notice to deny these waivers based on the impact of the effluent on recognized impaired receiving waters.

1/7/08- MeDEP issues a renewal permit to the town of Hampden to discharge untreated storm and waste water from a combined sewer overflow into the Souadabscook Stream (Penobscot River) during wet weather flows.

8/2008- CSO and collection system upgrades were done at the Bucksport Wastewater Treatment Plant. Working collaboratively since the mid-1990s, the Town of Bucksport and Wright-Pierce engineers developed and implemented the CSO abatement plan as part of a comprehensive wastewater treatment system upgrade. The project protects the Penobscot River ecosystem by exceeding regulatory standards for wastewater treatment processes. Peak flows do not need to be pumped uphill to the remote, main treatment plant; the new facility provides collection and treatment at the source prior to discharge to the river. The plant is fully automated and requires little maintenance.

12/31/08- Two licensed overboard discharges (1547, 4089) were removed and replaced with in ground systems (MeDEP, MacMillin).

2009- July 7, 2009- MeDEP issued a renewal for Elimination System permit #ME0023230 and Maine Waste Discharge License (WDL)#W006893-5O-E-R, to Penobscot Energy Recovery

Company for treated process waste water and storm water runoff to the Penobscot River (EPA NPDES 2010).

September 6, 2009 – MeDEP issued a renewal and amendment for Elimination System Permit # ME0102296 and Maine Waste Discharge License (WDL) # W007706-5S-C-R to Old Town Water District. The amendment administratively modified the permit (EPA NPDES 2010).

April 23, 2009 – MeDEP issued a Elimination System permit #ME0001104 and Maine Waste Discharge License (WDL)#W002032-5Q-D-M to MDIFW Cobb State Fish Hatchery for discharge to Cold Stream (Penobscot tributary in Enfield) (EPA NPDES 2010).

February and March 2009 – MeDEP issued 5 renewals for Elimination System permits #ME0036528, #ME0036511, #ME0036544, #ME0036552, #ME0036536, and 5 renewed Maine Waste Discharge Licenses (WDL)#W008077-5R-C-R, W008076-5R-D-R, W008079-5R-D-R, W008075-5R-D-R, W008078-5R-D-R, to Great lakes Hydro America LLC for discharge of non-contact cooling water to the Penobscot River or its tributaries (EPA NPDES 2010).

March 2009; Penobscot River drainage- MeDEP identified and fined a residence in Eddington for violating OBD conditions (failure to maintain chlorine in unit). The owners agreed to inspect, maintain, and keep records on OBD chlorination unit (DEP MER 2010). This was a fecal contamination issue.

July 2009; Penobscot River drainage- MeDEP identified and fined a business in Orland for violating stormwater management law for building 1.3 acres of parking gravel parking lot without a permit. This was an erosion issue, fecal contamination was unlikely. The business agreed to comply with the terms of an after the fact permit (if approved) or restore pre-existing vegetative cover (DEP MER 2010).

September 2009; Penobscot River drainage- MeDEP identified and fined a business in Bangor for violating sediment control best management practices and sediment erosion. Following DEP involvement, erosion control measures were promptly installed and maintained and were functioning as required (DEP MER 2010). This was an erosion issue, fecal contamination was unlikely.

December 31, 2009- MeDEP listed 25 Active OBDs in the waters of Area WX and upstream to Bradley in the Penobscot River. (Maine DEP2009a).
December 31, 2009- Two licensed overboard discharges (1590, 4089), both in Morse Cove, were removed and replaced with in ground systems (Maine DEP2009a).

2010- The Maine DEP Surface Water Ambient Toxins Monitoring Program tested shellfish in Wadsworth and Morse Cove during 2010.

2011- Shoreline surveys were conducted along Morse Cove Stream in October and Wadsworth Cove in May. Drive through surveys was conducted on 13 June, 11 July, 22 August and 18 October. A pair of black pipes, at the location of an OBD removed in 2001, were identified on 5/12/11 and identified as storm drains during an interview with the installer on 22 August. The shoreline survey database was updated to reflect this.

2012- OBD's Removed: One (DEP-ID 2914) at Verona Island, Area No. 35.

Pollution Sources Survey

The following sections include information on pollution sources which do or may impact water quality in growing area WX. Pollution sources that are reviewed in this section include domestic waste, including both private inground systems and over board discharges (OBDs), marinas and mooring fields, stormwater and pollution from non-point sources (streams), farms and other agricultural activities, domestic animals and wildlife areas, and recreational areas.

Table 1Area WX Pollution Source Table

Town	GASS ID	Pollution Area	Major PS	PS Type	Problem	Impact	Description
Penobscot	WX 18	35	Marina	MA	Y	PI	Marina, storage on site and across road,
Penobscot	WX 18	35	Stream	ST	Y	AD	Morse Cove Stream, history of high scores
Castine	WX 18	35	Stream	ST	Y	PI	Stream @ town line
Castine	WX 21	35	NPDES	OD	Y	AD	DEP ID 2274
Castine	WX 21	35	NPDES	OD	Y	AD	DEP ID 2503
Castine	WX 21	35	NPDES	OD	Y	AD	DEP ID 7947
Castine	WX 21	35	Stream	St	Y	AD	Bog Brook
Bucksport	WX 9	35	NPDES	WWTP	Y	AD	Bucksport WWTP
Bucksport	WX 28	35	NPDES	Tank farm	Y	AD	Webber Tanks
Bucksport	WX 29	35	NPDES	Process water	Y	AD	Verso paper Company

Figure 5Pollution Source Map A

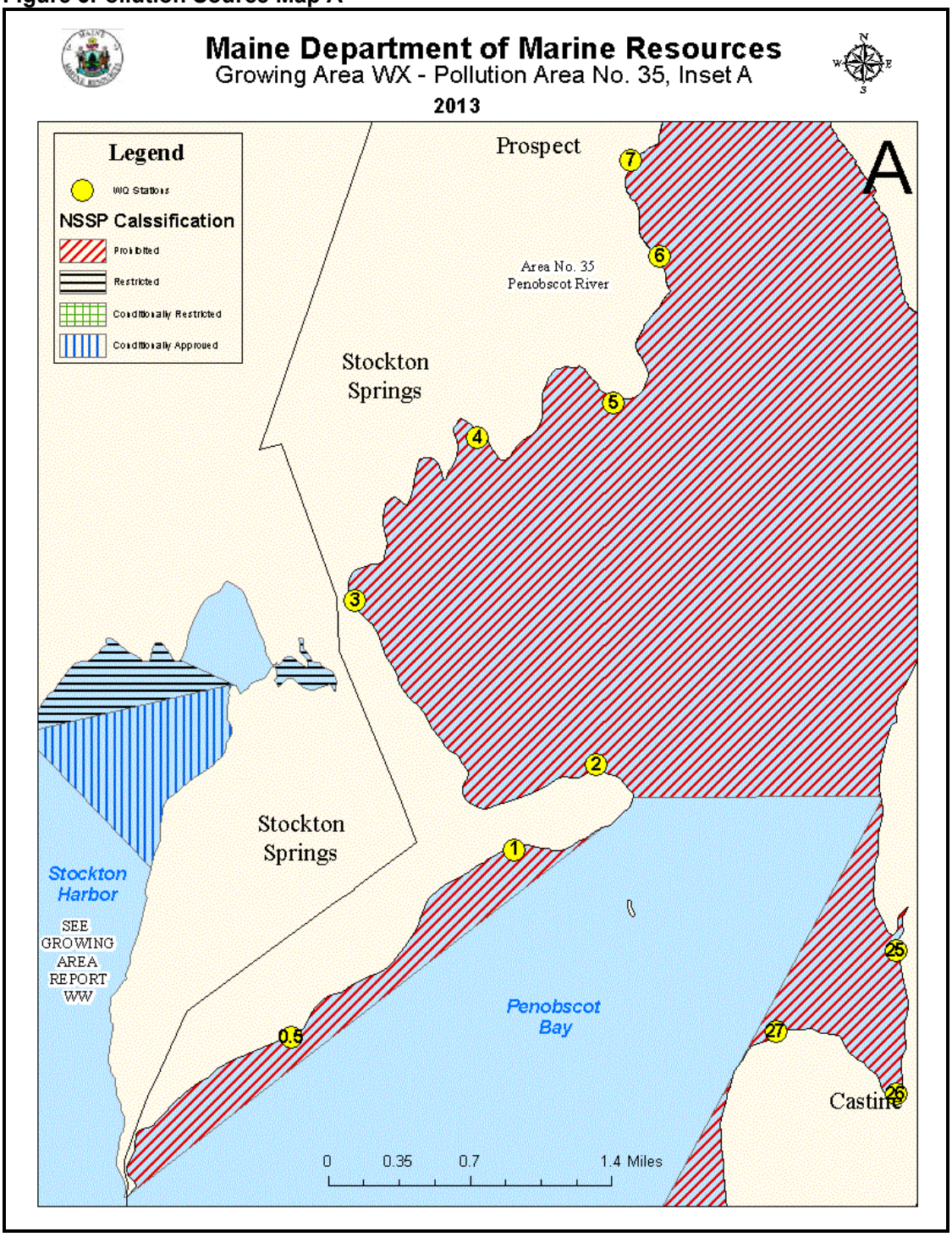


Figure 6 Pollution Source Map B

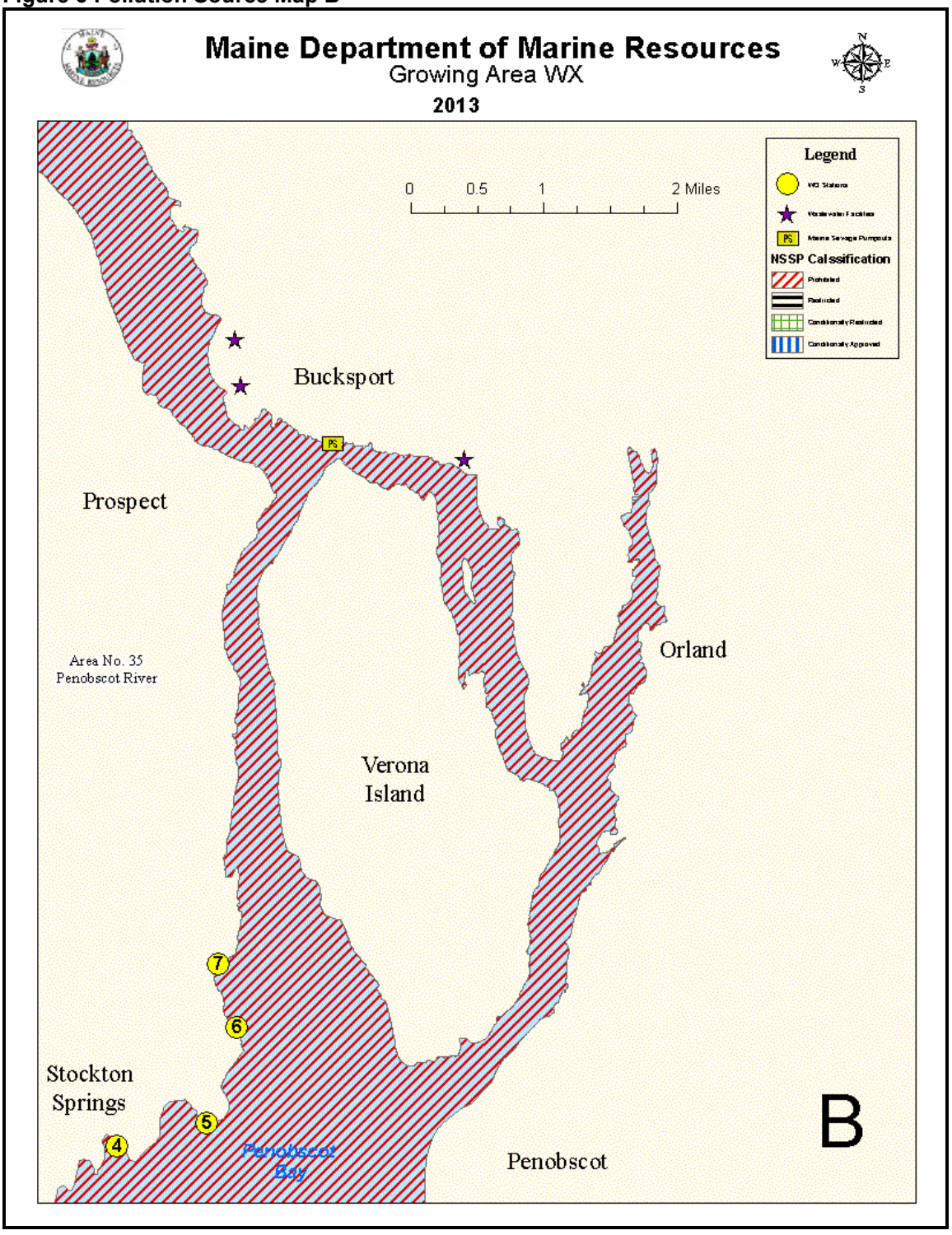
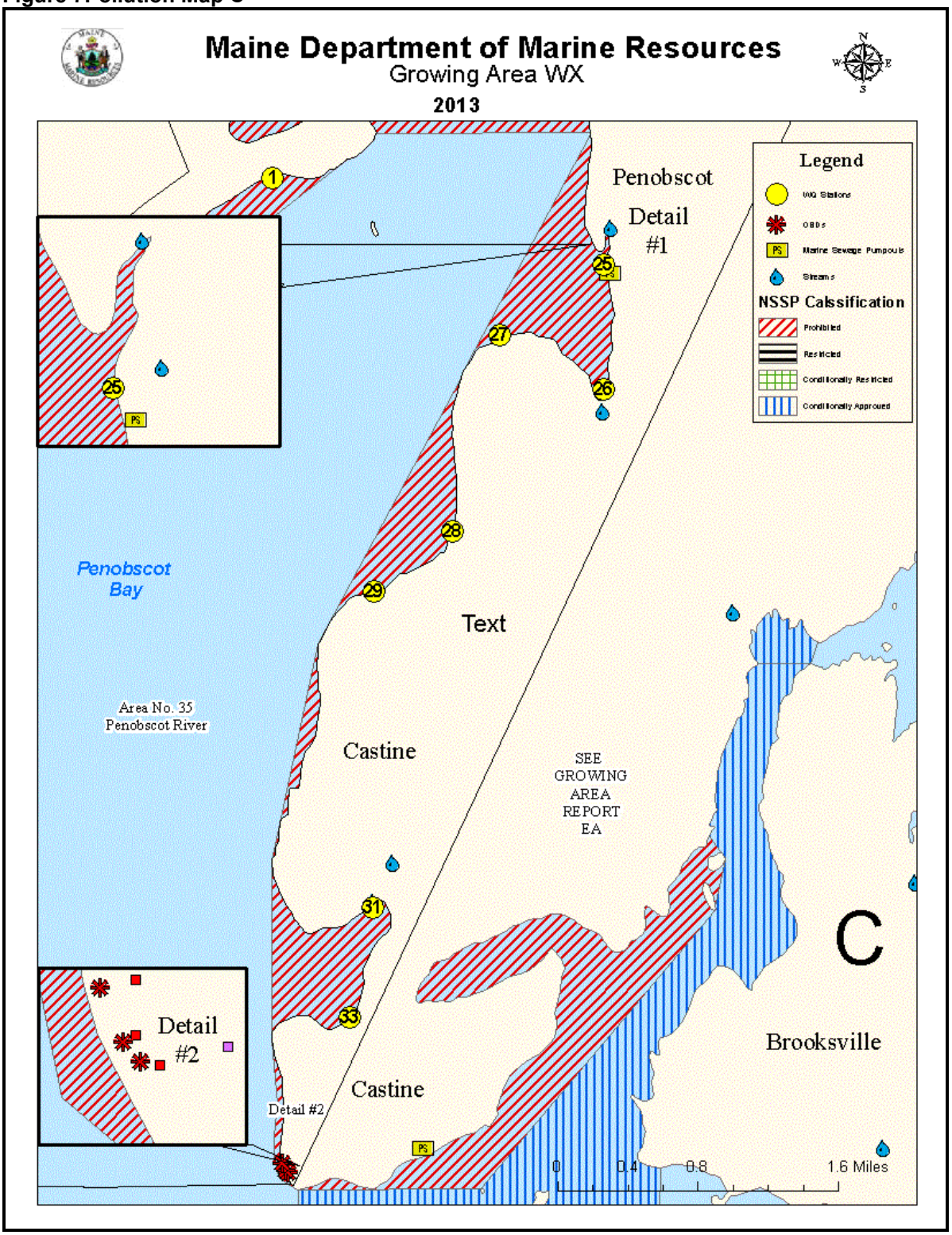


Figure 7Pollution Map C



Domestic Waste *(IG Systems and OBDs)*

Growing area WX consists of 30 two mile segments all within the towns of Stockton Springs, Verona Island, Bucksport, Orland, Penobscot and Castine. The LPI for Castine is Peter Vogell, for Stockton Springs it is John Larsen, for Penobscot it is Gerry Guse, for Verona Island it is Gerald Guse, for Orland it is Gerald Guse and for Bucksport it is Jeff Hammond The growing area consists of 379 residential in ground systems. All domestic waste systems were last visited in 2013 during the sanitary survey. There are no known issues with residential septic systems. No problem forms were filed with the towns in this growing area.

There are three over board discharge (OBD) that discharges its treated effluent into the waters of the Penobscot River in Castine. Four OBDs have been removed over the past three review years.

An overboard discharge (OBD) is the discharge of wastewater from residential, commercial, and publicly owned facilities to Maine's streams, rivers lakes, and the ocean. Commercial and residential discharges of sanitary waste have been regulated since the mid-1970 when most direct discharges of untreated waste were banned. Between 1974 and 1987 most of the "straight pipes" were connected to publicly-owned treatment works or replaced with standard septic systems. Overboard discharge treatment systems were installed for those facilities that were unable to connect to publicly-owned treatment works or unable to install a septic system because of poor soil conditions or small lot sizes.

All overboard discharge systems include a process to clarify the wastewater and disinfect it prior to discharge. There are two general types of treatment systems; mechanical package plants and sand filters. Sand filter systems consist of a septic tank and a sand filter. In such systems, the wastewater is first directed to a holding tank where the wastewater solids are settled out and undergo partial microbial digestion. The partially treated wastewater then flows from the tank into a sand filter, consisting of distribution pipes, layers of stone and filter sand, and collection pipes within a plastic liner. The wastewater is biologically treated as it filters down through the sand, and is then collected and discharged to a disinfection unit. Mechanical package plants consist of a tank, where waste is mechanically broken up, mixed and aerated; mechanical systems require electric power, and must have an operating alarm on a separate electrical circuit that will activate if the treatment unit malfunctions due to a power failure. The aerated treated wastewater is held in a calm condition for a time, allowing for solids to settle and for the waste to be partially digested by naturally occurring bacteria. The clarified water from the tank is then pumped off the top into a disinfection unit. There are two types of disinfection units, UV and chlorinators (most common). In a chlorinator, the treated water contacts chlorine tablets and remains in a tank for at least 20 minutes where bacteria and other pathogens are killed. The treated and disinfected water is discharged from the disinfection unit to below the low water mark of the receiving waterbody (the ocean, a river, or a stream) via an outfall pipe.

OBDs are licensed and inspected by the Maine Department of Environmental Protection. At each inspection, DEP looks for tags on each treatment unit identifying the service contractor and the last date of service. If an OBD is not properly maintained, or if the OBD malfunctions, it has the potential to directly discharge untreated wastewater to the shore; therefore, preventative closures are implemented surrounding every OBD located in growing area EA (Table 2). The

size of each closure is determined based on a dilution, using on the permitted flow rate of the OBD (in gallons per day, GPD), and the depth of the receiving water that each OBD discharges to; the fecal concentration used for this dilution calculation is $1.4X10^5$ FC /100 ml. All current closures are of adequate size to protect public health.

Table 2Area WX OBD Dilution Zone

ID	TOWN	Pollution Area	Mid Tide Depth	FLOW	Dilution in Acres Needed
2274	Castine	35	20	500	0.77
2503	Castine	35	20	500	0.77
7947	Castine	35	20	300	0.46

Municipal WWTP

Bucksport Wastewater Facility-

The plant is located on US Rt. 1, Bucksport. It is a primary plant with year round chlorination\dechlorination. Influent is domestic and commercial. The treatment plant is licensed to discharge 0.46 MGD into the Penobscot River (Class SC). There are also 2 combined sewer-storm water discharges releasing primary treated water of unknown volumes during wet weather flows. Operator license level is a minimum of Grade II. The current prohibited zone near this outfall is over 4000 acres. The dilution for this plant based on the licensed flow of .46 MGD a fecal loading of 140000 fc/100ml and a mid-tide depth of 7' and calls for a dilution zone of 2000 acres.

Table 3 Bucksport WWTP Dilution Calculation

Flow rate=	460,000	Gallons/day(GPD)
There are 7.481 gallons in one cu.ft., so GPD divided by 7.481=	61,489	Cu.Ft./day
There are 283 100ml units in one cu.ft., so 283 times Cu. Ft./day=	17,401,417	100ml. Units/day
Bacteria load=	140,000	FC colonies/100ml
Bacteria load times the number of 100ml. Units/day=	2,436,198,369,202	Total FC/day
or	2.44E+12	Total FC/day
Fecal coliform bacteria must be diluted down to <14 FC/100ml of water.		
FC colonies/day divided by 14=	174,014,169,229	100ml units of receiving waters for dilution.
There are 283 100ml units per cu.ft., so 100ml. Units divided by 283=	614,891,057	cu.ft. of receiving waters for dilution.
Average depth of receiving waters =	7	Ft.
Cu.ft. of receiving waters / by average depth=	87,841,580	Square ft. of surface water, or closure size.
Square ft. times 0.092903 =	8,160,746	Square meters
Square meters times 0.0002471=	2,016.5	acres

Industrial Pollution

The Penobscot River watershed has many industrial operations that discharge into Growing Area WX. These include several paper-making mills, runoff water from oil and chemical storage facility parking areas and manufacturing plants. The impacts have historically included heavy metals, dioxins, petroleum products and chemicals. These industry discharges are regulated and inspected by the Maine Department of Environmental Protection and there are monitoring sites within the watershed.

The Penobscot River has fuel and asphalt tanker-barge traffic that go as far upriver as Bangor. There are large storage tanks for heavy oil, gasoline and heating oil in Bucksport and Bangor. These tanks are near the river edge and have product off-load wharves on the river. Tanks have containment walls and booms in the event of an accidental leek in a tank or spillage when unloading. The oil response team from the Maine DEP contacts Maine Marine Resources when a spill occurs and a decision can be made whether a shellfish closure is necessary.

The now defunct HoltaChem Manufacturing Corporation in Orrington is presently the site of a mercury metal superfund remediation site. (www.epa.gov/region01/superfund/index) HoltraChem Manufacturing, a 235 acre facility in Orrington, manufactured chlorine, sodium hydroxide (caustic soda), sodium hypochlorite (chlorine bleach), hydrochloric acid, and chloropicrin (a pesticide). The site is currently closed and HoltraChem has dissolved as a company. Cleanup work at the site is proceeding with the cooperation of Mallinckrodt Inc/Tyco Healthcare, a former site owner. The facility has 5 landfills containing hazardous waste on-site. Corrective Action was required under a section 3008(h) order. Three public meetings, several "office hours", and briefings for the press and stakeholder groups have been held and five newsletters circulated to involve the public in the work at this site. The Maine Peoples Alliance and Natural Resources Defense Council successfully pursued a RCRA Section 7002 citizen suit against HoltraChem and Mallinckrodt which will force a more detailed study of the impact of the site on the Penobscot River. EPA and Maine Department of Environmental Protection are proceeding with cleanup of the site and moderately to heavily contaminated sediment immediately adjacent to the site in the Penobscot River. This plant is approximately 18 miles up river from the growing area, had a liquid mercury spill in February of 1998. This plant has since been discontinued and the site stabilized under the direction of the Maine Department of Environmental Protection. There has been concern that the mercury has traveled downriver to the estuary. Testing (1999- Maine Peoples Alliance-Natural Resources Defense Council and by Mallinckrodt Corporation) found concentrations exceeding the NOAA recommendations in nearly all samples from Frankfort Flats and Fort Point Cove. Frankfort Flats values exceeded 4.6 ppm . A sample of shellfish tissue tested by the Stockton Clam Committee at X 3 (Fort Point Cove) had a mercury level of 0.08 mg/kg (wet wt). The Maine DEP health level for mercury metal contamination is 0.20 mg/kg wet weight of shellfish tissue. Table 6 and 7 shows DEP SWAT program results for metals levels in the lower estuary. These sites are adjacent to the margins of the Prohibited Area C35. These sub-advisory levels of mercury and other metals contamination adjacent to the prohibited zone margin support the closure line.

Marinas and Mooring Fields

Several mooring fields (groups of 10 or more moorings) are scattered throughout the growing area with the largest number of boats in Bangor-Brewer, Hampden, Winterport, Castine and Bucksport. These mooring fields are both pleasure and work boats (lobster boats, trawling vessels). These mooring clusters are in prohibited areas. Individual pleasure boats are on moorings scattered randomly within the growing area. Fuel wharfs are located in Castine, Bucksport, Winterport, Hampden and Bangor. These wharfs are all in prohibited areas.

There are small boats launching facilities in Bangor, Hampden, Orrington, Winterport, Bucksport, Stockton Springs and Castine. These facilities are primarily used as launching sites for shell fishermen, duck hunters, skiffs for larger boats and recreation fishermen. Formal marinas with wharfs, fuel, slips, etc. are located in Hampden, Winterport, Bucksport and Castine. All of these areas are in current prohibited zones due to WWTP dilution zones.

Stormwater

Several of the cities and large towns on the Penobscot River have storm sewers that discharge into the river. Some of the storm water is treated. Many of the storm water pipes drain large parking lots or city streets covered with oils, gasoline, fertilizers and pesticides. Rural sections of Area WX have no formal rainwater collection systems. Along roadways several storm water pipes and ditches of varying diameters were identified during the course of the shoreline surveys. These all discharge into Prohibited areas.

Stormwater runoff is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not percolate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated (US EPA 2009). Thus, stormwater pollution is caused by the daily activities of people within the watershed. Currently, polluted stormwater is the largest source of water quality problems in the United States.

The primary method to control stormwater discharges is the use of best management practices (BMPs). In addition, most major stormwater discharges are considered point sources and require coverage under an NPDES permit. In 1990, under authority of the Clean Water Act, the U.S. EPA promulgated Phase I of its stormwater management program, requiring permitting through the National Pollution Discharge Elimination System (NPDES). The Phase I program covered three categories of discharges: (1) “medium” and “large” Municipal Separate Storm Sewer Systems (MS4s) generally serving populations over 100,000, (2) construction activity disturbing 5 acres of land or greater, and (3) ten categories of industrial activity. In 1999, US EPA issued Phase II of the stormwater management program, expanding the Phase I program to include all urbanized areas and smaller construction sites.

Although it is a federal program, in the state of Maine, the Phase II Stormwater permit is issued and regulated by the Maine DEP (Chapter 500 and 502). Under the MS4 regulations, each municipality must implement the following six Minimum Control Measures: (1) Public education

and outreach, (2) Public participation, (3) Illicit discharge detection and elimination, (4) Construction site storm water runoff control, (5) Post-construction stormwater management, and (6) Pollution prevention/good housekeeping. The permit required each city or town to develop a draft Stormwater Management Plan by September 3, 2003 that will establish measurable goals for each of the Minimum Control Measures. The Town must document the implementation of the Plan, and provide annual reports to the Maine DEP.

Non-Point Pollution Sources *(streams, etc)*

The most significant source of non-point pollution in WX is the Penobscot River. The Penobscot river drains 8,570 square miles of central and northern Maine with 47 populated municipalities along the river and its tributaries. The population of the drainage is approximately 170,000 (Maine SPO 2007). At this time two minor coastal streams, Morse Cove Stream in Penobscot, and Bog Brook in Castine are being monitored in conjunction with examining improved water quality scores in Morse Cove and Wadsworth Cove (Table 4).

Table 4 Area WX Stream Samples

Town	Stream Name	ID	Pollution Area	Date	FECAL	Flow GPM
Stockton Springs	un-named stream	WX00005.55	35	17-Apr-13	1.9	5
Stockton Springs	un-named stream	WX00005.85	35	17-Apr-13	1.9	3
Stockton Springs	un-named stream	WX00006.40	35	17-Apr-13	1.9	20
Stockton Springs	un-named stream	WX00039.50	35	01-May-13	1.9	5
Stockton Springs	un-named stream	WX00041.50	35	06-May-13	2	15
Stockton Springs	un-named stream	WX00041.95	35	06-May-13	1.9	15
Stockton Springs	Louder Brook,	WX00051.10	35	06-May-13	1700	50
Stockton Springs	Louder Brook,	WX00051.10	35	28-May-13	1700	500
Stockton Springs	un-named stream	WX00060.10	35	16-May-13	20	420
Stockton Springs	un-named stream	WX00064.50	35	28-May-13	5.5	3100
Stockton Springs	un-named stream	WX00065.10	35	28-May-13	10.9	30
Penobscot	Clement Brook,	WX00424.00	35	25-Aug-10	440	1.5
Penobscot	Clement Brook,	WX00424.00	35	01-Dec-10	1.9	1622
Penobscot	Clement Brook,	WX00424.00	35	11-Jul-11	371	371
Penobscot	Clement Brook,	WX00424.00	35	22-Aug-11	1700	20621
Penobscot	Morse Cove Stream	WX00444.00	35	25-Aug-10	66	3
Penobscot	Morse Cove Stream	WX00444.00	35	26-Aug-10	1600	1200
Penobscot	Morse Cove Stream	WX00444.00	35	01-Dec-10	4	452
Penobscot	Morse Cove Stream	WX00444.00	35	11-Jul-11	540	180
Penobscot	Morse Cove Stream	WX00444.00	35	22-Aug-11	1700	1264
Penobscot	Morse Cove Stream	WX00444.00	35	18-Oct-11	60	271
Castine	un-named stream	WX00444.10	35	18-Oct-11	13	97

Town	Stream Name	ID	Pollution Area	Date	FECAL	Flow GPM
Castine	"Bog Brook"	WX00489.00	35	25-Aug-10	142	60
Castine	"Bog Brook"	WX00489.00	35	01-Dec-10	16	54
Castine	"Bog Brook"	WX00489.00	35	11-Jul-11	500	270
Castine	"Bog Brook"	WX00489.00	35	22-Aug-11	1700	3862
Castine	land drain	WX00509.10	35	13-Jun-11	26	198
Castine	land drain	WX00509.10	35	22-Aug-11	1.9	303
Castine	land drain	WX00513.00	35	13-Jun-11	740	1
Castine	land drain	WX00513.00	35	11-Jul-11	300	1
Castine	land drain	WX00513.00	35	22-Aug-11	280	3
Castine	land drain	WX00513.00	35	18-Oct-11	6	1

No streams are used for dilution calculations and all are located in current pollution area 35.

Agricultural Activities

There are no known commercial animal agricultural operations which could drain directly into in the growing area nor drain directly into the Penobscot River between the growing south of Bangor/Brewer (Maine DEP AG 2011, MOFGA 2011).

Domestic Animals and Wildlife Activity

Area WX is largely an urban and suburban area with numerous domestic animals including horses. Tracks and other sign observed during sampling and shore survey indicate a significant deer population in the area. Beaver lodges have been observed on drainages flowing into area WX.

Conservation/Recreation Areas

Fort Point state park is located on the western shore of area WX. The park has some beach and unleashed dogs were observed on the beach during triennial shoreline survey. The area is currently closed to shellfish harvest.

Fort Knox State park is located on the western shore of area WV north of the Verona Island Bridge. The park OBD has been removed and is no longer a pollution source. The fortified shoreline is generally inconvenient to access to access for pet walking and the area is currently closed to shellfish harvest.

Hydrographic and Meteorological Assessment

Tides

Coastal Maine experiences a mixed, semi-diurnal tide, with diurnal inequalities that are more pronounced on spring tides. The mean range of tide is 10 feet at Castine. (2007 Coastal Pilot) Currents in the area are predominantly driven by the flow of the Penobscot and Bagaduce rivers and tides. All along the coast of eastern Maine, the tide generally floods to the north and east and ebbs to the south and west. To examine the effects that tidal stage might have on fecal coliform concentrations, data collected under the Systematic Random sampling strategy (all months, all samples) were queried for all active sample sites (2001-2013) and the data set was five or greater points. Table 5 below lists the tide stages in minutes referenced from low tide. The data set was than analyzed for geomean based on tide stage. This data can be seen in table 6 below. The growing area is a large shallow estuary and water is frequently only present at many sample sites during flooding, ebbing and high tide periods. This is evident in Table 7 by the relatively low numbers of samples at lower tides for many of the sample stations.

Table 5Tide stage Key (minutes from low)

Tide stage	Minutes from Low tide
L	(+-) 30 minutes
LF	30-90
F	91-270
HF	271-329
H	(+-) 30 minutes
HE	(-270) - (-330)
Ebb	(-90) - (-270)
LE	(-30) - (-90)

Table 6 Area WX Tide Geomean

Station	E	F	H	HE	HF
WX000.50	6.1	5.2		3.5	3.8
WX001.00	5.1	5.3		3.1	10.4
WX002.00	11.6	6.0	10.4	3.7	10.7
WX003.00	11.0	6.9	16.6	5.6	9.8
WX004.00	9.8	11.4	15.6	7.4	7.2
WX005.00	7.5	12.3	11.2	5.1	9.2
WX006.00	7.6	12.5	22.6		11.2
WX007.00	15.0	37.0	15.1		22.1
WX025.00	5.5	11.5	5.6	26.8	9.9

Station	E	F	H	HE	HF
WX026.00	6.3	12.9	5.2	17.4	5.0
WX027.00	6.1	8.3	4.4	7.0	3.4
WX028.00	5.3	11.2	6.2	3.6	5.6
WX029.00	4.5	7.1	5.3	2.7	3.1
WX031.00	4.9	7.5	5.1	3.5	3.0
WX033.00	4.0	6.5	4.7	2.9	5.5

Station WX 3 and 4 show elevated geomean scores at high tide. Both these stations are located in Fort Point Cove and due to the topography of the bay it is difficult to get out far enough away from shore to sample in water that is not inside the wrack and grass line. This run is now done by boat making this problem less likely to impact any sampling efforts. Station WX 7 shows elevated geomean scores at all samples stages. This station is in a current prohibited area and was deactivated due to loss of access. Station WX 25 and 26 have elevated geomean scores at the high ebb tide stage bot are located in the current prohibited zone. This area has no data for that time period from low tide to 90 minutes either side of low because there was not the required minimum of 5 samples for these tide periods.

Rainfall

The mean annual precipitation in growing area WX is approximately 44 inches. The precipitation is not evenly distributed throughout the year. The wettest months are February-June and September-November. August is typically the driest month. Much of the precipitation in the winter comes as snow and may affect runoff rates when melting in spring. It is likely that after prolonged periods of dry weather, significant rainfall (>1" over 24 hours) will cause some pollution from non-point runoff. It is unclear how much of an effect major rainfall events have on water quality due to variability of ground water saturation, history of recent significant rainfall that may have washed non-point pollution sources away, hard ground, ledge, wildlife or agriculture activity. Rainfall is monitored locally at Castine and Searsport Rain stations. To look at the effects of rainfall on the growing area data was run for the last 12 years at all active stations for dry periods with no rain within 24 hours of collection, rainfall events of between .1 and 1" of rain and rainfall events of greater than 1" but less than 2" (any event of greater than or equal to 2" of rain in 24 hours will result in a flood closure). This data was then broken down into P90 for each active station with greater than 5 samples that met each condition. It was than compared to dry data where no rainfall fell within 24 hours of sample collection. This data can be seen in table 7.

Table 7Area WX Rain P90

Station	Class	Dry P90	Less than 1"P90	Between 1-2"P90	Dry Count	<1"Count	Between 1-2" Count
WX000.50	P	22	23	9	151	49	7
WX001.00	P	23	24	145	179	57	7
WX002.00	P	37	43	13	177	55	7
WX003.00	P	43	55	12	177	56	6
WX004.00	P	57	73	57	168	52	7

Station	Class	Dry P90	Less than 1"P90	Between 1-2"P90	Dry Count	<1"Count	Between 1-2" Count
WX005.00	P	33	50	18	175	54	6
WX006.00	P	61	110	47	169	52	6
WX007.00	P	126	109	151	164	49	6
WX025.00	P	63	155	568	220	71	11
WX026.00	P	47	71	863	223	73	10
WX027.00	P	23	45	42	146	47	9
WX028.00	P	27	48	228	194	55	13
WX029.00	P	17	21	29	224	74	12
WX031.00	P	20	20	40	230	73	11
WX033.00	P	13	24	76	221	74	12

As to be expected with the large upland area drained by the Penobscot River rain has an impact on stations throughout this growing area. All upriver stations are impacted by rainfall and are in preheated zones. Stations WX 31 and 33 are located downriver and only seem impacted during heavier rainfall events of between 1-2”. As there is a stream (Bog Brook) that drains directly to the cover where these stations are located this seems to be the likely cause versus the flow from the Penobscot itself.

Winds

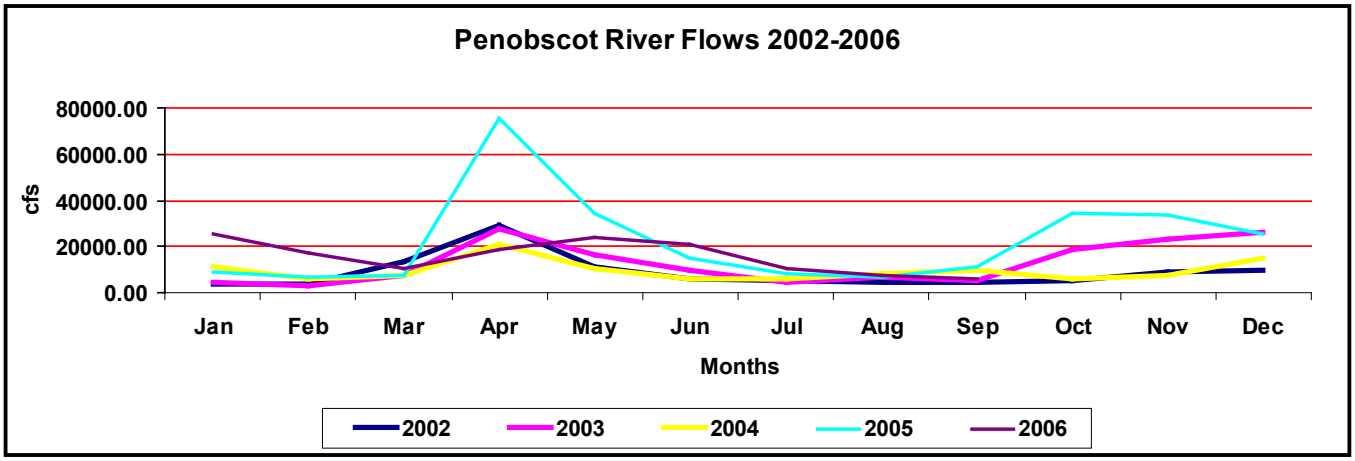
Migratory weather systems cause winds that frequently change in strength and direction. Gulf of Maine winds are generally westerly, but often take on a northerly component in winter and a southerly one in summer. Strongest winds are generated by lows and cold fronts in fall and winter and by fronts and thunderstorms during spring and summer. Extreme winds are usually associated with a hurricane or severe northeaster and can reach 125 knots. Sustained winds of 100 knots occur about every 50 years on average; gusts are usually about 30 percent higher.

Coastal winds are complex since they are influenced by the topography. Over land speeds are reduced. However, channels and headlands can redirect the wind and even increase the speed by funneling the wind. In general, winds have southerly components in summer and northerly ones in winter. In sheltered waters near Rockland, Portland, and Brunswick, there are a large percentage of calms, particularly during the morning hours. When the existing circulation is weak and there is a difference between land and water temperatures, a land-sea breeze circulation may be set up. As the land heats faster than the water, a sea breeze is established during the day; this onshore flow may reach 15 knots or more. At night, the land cools more rapidly, often resulting in a weak breeze off the land. In many locations, the sea breeze serves to reinforce the prevailing summer wind. Analysis of GOMOOS data (2001-2006) show winter winds along coastal Maine are typically from the west-northwest during clear periods and from the northeast during storms. In the spring, summer and fall, predominant winds are from the south-southwest. West, northwest and north winds are common during fall and winter. Although less frequent, winds from the northeast, north and northwest directions are typically stronger than winds from the south. In the summer, winds tend to be on shore due to heated, rising air over land and cooler ocean air flowing into the void.

River Discharge

Stream flow in mid-coast Maine exhibits seasonal variation, with the highest flows occurring in the spring (due to snowmelt, spring rains, and low evapo-transpiration) and the mid-to late fall (due to fall rains and low evapo-transpiration). To illustrate the seasonality of stream flow in Maine, mean monthly flow for the Penobscot River, West Enfield, Maine (Drainage area 8610 square miles), gauged by the U.S. Geological Survey above the tidal dam, is plotted in Figure

Figure 8Monthlky Mean River Flows (Penobscot River)



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Any possible future openings in the upper portion of the river should compare fecal coliform scores to river flows to determine if there is any correlation between the two. The lower river near stations WX 28-33 should also be checked but this portion of the river has greater tidal influence and may not be influenced as greatly from freshwater river flow.

Salinity

Salinity generally tends to be lowest in the spring, due to spring rains and snowmelt/runoff and in late fall from rainfall. Summer and early autumn show the highest values of salinity, due to the relatively low stream flows at this time of year. Salinity data, taken from routine (random/prescheduled) ambient monitoring data from sites near the mouths of rivers or streams approximate the stream flow patterns and influence of fresh water inputs on the growing area. However, partial salinity stratification can occur during times of heavy rainfall and runoff. It is well recognized that freshwater influence from runoff can contribute to elevated bacterial loading near shore. Queries of the sample data in Area WX for average salinity by month (2001-2013) shows sample sites with salinities that averaged less than 10 ppt per month. These stations are highlighted in yellow.

Table 8Area WX Salinity (ppt) Avg. by Month

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	De c
WX000.50	24	28		11	18	23				26	30	24
WX001.00	26	28		10	15	22				25	29	25
WX002.00	20				14	21				25	25	23
WX003.00	24			11	16	20				22	27	23
WX004.00	20			11	18	20				22	26	23
WX005.00	22			3	13	19				22	27	24
WX025.00	16	22	19	16	15	19	25	25	26	22	20	17
WX026.00	13	22	16	13	16	19	25	24	26	20	4	17
WX027.00	17	23	23	16	16	22	24	25	25	22	17	21
WX028.00	13	28	24	20	20	22	26	25	27	24	24	23
WX029.00	21	27	23	19	21	23	26	26	27	25	26	24
WX031.00	12	28	26	18	23	23	26	27	28	26	28	26
WX033.00	23	29	26	24	24	25	26	27	28	27	32	26

There were only three incidents when a station had an average salinity of 10ppt or less occurred during the months of April and November. As indicated earlier these are the times of the year that we would expect high river flows and higher rainfall amounts.

Seasonal Effects on FC Concentrations

To examine the effects that seasons may have on fecal coliform levels in Growing Area WX, the historical fecal coliform data of the ambient sites were grouped according to season and results are presented in table 9. To focus the analysis on relatively current data, this analysis included fecal coliform results collected from 2001 to 2013. The collection dates were queried to conform to the seasonal groupings. The seasons were divided into those months when summer and fall human impact is the greatest as well coinciding with seasonal waterfowl migrations. These months are June through October (Summer/Fall). The season expected to give the least amount of human and wildlife impact is November through May (Winter/Spring). Table 9 demonstrates the P90 and geomean for each station in area WX for these two seasonal periods.

Table 9Area WX Seasonal P90

Station	Class	Spring/Winter P90	Summer/Fall P90	Spring/Winter Count	Summer/Fall Count
WX000.50	P	8.75	23.90	24	29
WX001.00	P	6.72	55.30	30	33
WX002.00	P	32.73	44.35	29	33
WX003.00	P	39.71	52.26	30	32
WX004.00	P	57.97	62.77	27	32
WX005.00	P	29.92	47.29	30	31
WX006.00	P	28.10	149.92	30	29

Station	Class	Spring/Winter P90	Summer/Fall P90	Spring/Winter Count	Summer/Fall Count
WX007.00	P	60.71	192.91	26	29
WX025.00	P	36.68	141.28	34	43
WX026.00	P	34.87	61.48	30	48
WX027.00	P	20.26	33.71	21	31
WX028.00	P	11.11	49.74	23	44
WX029.00	P	14.79	19.90	33	46
WX031.00	P	17.54	19.77	35	45
WX033.00	P	8.97	23.36	33	46

Every station in the growing area shows an increase during the summer and fall months. This is not unexpected as this portion of Maine sees a large influx of people during these months along the whole Penobscot River corridor. Once again the lower section of river showed the least amount of impact as this section has much greater influence from ocean tides.

Aquaculture/Wet Storage Activity

As this area is currently classified as prohibited there are no shell stock or finfish aquaculture sights in this area.

Water Quality Review

There are presently thirteen (13) active water sampling sites in Growing Area WX. They are collected by boat from near-shore sites in Random Runs 03B under the Systematic Random Sampling protocol (SRS). Sample sites are established to monitor known or potential pollution sources and on the margins of established closures. Sampling is done year-round. It is recognized that frequently access, icing and safety considerations prevent some stations being sampled on scheduled dates. Currently all station in Growing Area WX meet their current NSSP classification standard. Stations WX .5, 29, 31 and 33 currently meet the standard for approved classification. The stations in Wadsworth Cove (WX 31 and 33) are being suggested for an upgrade based on this survey and current P90 scores. Station WX .5 meets the standard for approved but is located in a cove where lobster harvest was just suspended based on heavy metal contamination of the tomalley. Until more information is gained about the possible impact to shellstock this area should remain prohibited.

Table 10 Area WX Current P90 most recent 30 samples

Station	Class	Count	MFCount	GM	SDV	MAX	P90	Appd_Std	Restr_Std	Min_Date
WX000.50	P	30	22	3.8	0.48	240	16.2	35	191	3/28/2005
WX001.00	P	30	22	6.4	0.59	240	37	35	191	5/10/2005
WX002.00	P	30	22	8.8	0.65	460	61.8	35	191	5/10/2005
WX003.00	P	30	22	8.1	0.59	93	46.9	35	191	5/10/2005
WX004.00	P	30	21	6.9	0.59	93	39.9	35	195	3/28/2005
WX005.00	P	30	21	10.1	0.53	122	49	35	195	3/28/2005
WX026.00	P	30	30	9	0.81	1700	99.9	31	163	3/25/2009

Station	Class	Count	MFCount	GM	SDV	MAX	P90	Appd_Std	Restr_Std	Min_Date
WX028.00	P	30	30	5.5	0.71	840	45	31	163	3/25/2009
WX029.00	P	30	30	4.7	0.59	140	27	31	163	3/25/2009
WX031.00	P	30	30	3.7	0.5	66	16.3	31	163	3/25/2009
WX033.00	P	30	30	3.6	0.46	36	14.4	31	163	5/4/2009

Water Quality Discussion and Classification Determination

Growing Area WX has environmental and human impacts similar to the remainder of the Maine coast east of Penobscot Bay. Coastal community development is rapidly expanding with homes and businesses near the mainland shores and on islands. This development increases the potential pollution risks to the traditional shellfish harvesting areas and the newly emerging shellfish aquaculture business.

Licensed discharges, environmental factors, heavy metals-toxins and seasonal periods have the greatest pollution impacts on the growing area. The Penobscot River is the largest conveyor of pollutants to the growing area. Pollution loading is most likely originating on the near shore land and impacting the harvesting areas and ocean waters by non-point wide-spread runoff, streams and ditches or illegal and/or licensed discharges.

Known licensed pollution point sources have surrounding Prohibited zones large enough to adequately dilute the discharge effluents to < 14 FC/100 ml. of the receiving waters. Environmental factors and seasonal periods have pollution impacts on the growing area.

Review of the shoreline survey data, pollution source impact evaluations, analyses of tidal, seasonal, and rainfall effects, ambient water quality data, and the hydrographic information supports changes in the classification of the below listed areas:

Recommendation for Future Work

1. Upgrade Wadsworth Cove from prohibited to approved. Keep area above bridge in Wadsworth Cove closed based on Bog Brook Stream scores.

2. Take a look at sample station scores in Fort Point Cove (Stockton Springs) compared to river flows to determine if this area can be upgraded based on Penobscot River Flows.

Appendix1. Key to Water Quality Table Headers

Station = water quality monitoring station

Class = classification assigned to the station; prohibited (P), restricted (R), conditionally restricted (CR), conditionally approved (CA) and approved (A).

Count = the number of samples evaluated for classification, must be a minimum of 30.

MFCNT = the number of samples evaluated with the MTec method (included in the total Count column)

Geo_Mean = means the antilog (base 10) of the arithmetic mean of the sample result logarithm (base 10).

SDV = standard deviation
Max = maximum score of the 30 data points in the count column

P90 = 90th percentile

APPD_STD = the 90th percentile, at or below which the station would meet approved criteria in the absence of pollution sources or poisonous and deleterious substances.

RESTR_STD = the 90th percentile, at or below which the station would meet restricted criteria.