WASTEWATER TREATMENT FACILITY AND SEWER COLLECTION SYSTEM

CLIMATE ADAPTATION PLAN

for the

WELLS SANITARY DISTRICT

Wells, Maine

January 2020

WRIGHT-PIERCE
Engineering a Better Environment

WELLS SANITARY DISTRICT
WELLS, MAINE

WASTEWATER TREATMENT FACILITY & SEWER COLLECTION SYSTEM CLIMATE ADAPTATION PLAN

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WELLS SANITARY DISTRICT– CLIMATE ADAPTATION PLAN

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LIST OF ACRONYMS

BFE	Base Flood Elevation
CAP	Climate Adaptation Plan
CCTV	Closed Circuit Television
CDBG	Community Development Block Grant
CWSRF	Clean Water State Revolving Fund
ENR	Engineering News Record
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
ft	Feet
GIS	Geographic Information System
GPM	Gallons per minute
HAT	Highest Astronomical Tide
HP	Horsepower
HVAC	Heating, Ventilation and Air Conditioning
I/I	Inflow and Infiltration
kW	kilo-Watt
LiDAR	Light Detection and Ranging
Maine DEP	Maine Department of Environmental Protection
MGD	Million gallons per day
MLE	Modified Ludzack-Ettinger
NEIWPCC	New England Interstate Water Pollution Control Conference
NEMA	National Electrical Manufacturers Association
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
PPE	Proper Protective Equipment
PS	Pump Station

RAS	Return Activated Sludge
RD	Rural Development
SLOSH	Sea, Lake and Overland Surges from Hurricanes
SLR	Sea Level Rise
SRF	State Revolving Fund
SSO	Sanitary Sewer Overflow
TR	Technical Report
USDA	United States Department of Agriculture
VFD	Variable Frequency Drive
WAS	Waste Activated Sludge
WIFIA	Water Infrastructure Finance and Innovation Act
WSD	Wells Sanitary District
WWTF	Wastewater Treatment Facility

EXECUTIVE SUMMARY

The Wells Sanitary District (District) was awarded $20,000 by the Maine Department of Environmental Protection (Maine DEP) Clean Water State Revolving Fund (CWSRF) program to develop a Climate Adaptation Plan (CAP) for the District's Wastewater Treatment Facility (WWTF) and sewer collection system assets.

The District owns and operates the Wells Sanitary District WWTF located at 197 Eldridge Road in the Town of Wells, Maine, a sanitary sewer collection system that is 42 miles in length and ten major wastewater pumping stations. Several privately-owned wastewater pump stations also convey wastewater flows from private residences and businesses to the District's sewer collection system. The WWTF is permitted to treat wastewater flows up to a peak hourly flow capacity of 5.0 million gallons per day (MGD).

The goals of the CAP study are to:

- Review the possible effects of climate change to the Wells, Maine region;
- Identify and assess possible climate change-related threats specific to the District's wastewater treatment and collection systems and their reliability;
- Evaluate potential adaptation measures to the identified hazards; and
- Provide a cost-effective implementation plan to help protect the District's critical assets and maintain wastewater treatment and collection system reliability.

Potential climate change impacts and the associated hazards applicable to the District's assets and personnel were identified in Section 3 of the report. A risk assessment, including the likelihood of potential hazards affecting the District's critical assets, was conducted and the findings were summarized in Table 3-1 (System-wide), Table 3-2 (WWTF), Table 3-3 (Pump Stations) and Table 3-4 (Sewer System) in Section 3 of the report as well.

Possible adaptation measures were identified and evaluated based on the findings of the risk assessments in Section 4. The recommended adaptation measures were summarized in Table 4-1 (System-wide), Table 4-2 (WWTF), Table 4-3 (Pump Stations) and Table 4-4 (Sewer System).

Recommended adaptation measures can be grouped into one of two categories, operational or asset-specific measures. Operational adaptation measures are tasks or procedural changes that District staff could undertake at minimal cost to prevent or mitigate potential hazard consequences. Asset-specific measures include non-routine or one-time tasks, in-depth studies or evaluations, design modifications, or capital expenditures to achieve the goal of preventing or mitigating the potential hazard consequence.

Table 5-1 in Section 5 summarizes the overall recommended adaptation measure priorities for the WWTF, pump stations and sewer collection system. Table 5-1 also includes conceptual-level project cost estimates for the asset-specific adaptation measures that will require a capital expense. Section 5 also includes a basis for the conceptual-level cost estimates and possible funding sources available to the District for the recommended adaptation measures.

SECTION 1
INTRODUCTION

1.1 GOALS & APPROACH

The Wells Sanitary District (District) was awarded $20,000 by the Maine Department of Environmental Protection (Maine DEP) Clean Water State Revolving Fund (CWSRF) program to develop a Climate Adaptation Plan (CAP) for the District's Wastewater Treatment Facility (WWTF) and sewer collection system assets.

The goals of the CAP are to review the possible effects of climate change, identify and assess possible climate change-related threats specific to the District's wastewater treatment and collection systems and their reliability, evaluate potential adaptation measures, and provide a cost-effective implementation plan to help protect the District's critical assets and maintain wastewater treatment and collection system reliability. The District has retained Wright-Pierce to assist with the development of the CAP.

The approach to developing the District's CAP included:

i. A review of historic information on environmental hazards based on past observations by District personnel, infrastructure data, GIS information and record drawings, readily available Federal Emergency Management Agency (FEMA) 100-year Base Flood Elevation (BFE) floodplain mapping, including the addition of 2 to 3 feet of elevation above the FEMA 100-year BFE based on NEIWPCC's *TR-16: Guides for the Design of Wastewater Treatment Works* guidance on flood protection. The FEMA 100-year BFE in Wells ranges from 12 to 20 ft, depending on geographic location and proximity to nearby waterbodies.

ii. Supplemental field reconnaissance by Wright-Pierce personnel.

iii. An evaluation of the effects of floodplain inundation including sea level rise and Category 1 hurricane scenarios on critical assets and system reliability as well as the ability to access critical infrastructure during periods of floodplain inundation.

iv. An evaluation of the impacts from changes to precipitation patterns, storm intensity, duration and frequency on critical assets.

v. An evaluation of weaknesses in community or utility support systems that may be impacted by climate change and the consequences on the Town's system reliability.

vi. An evaluation of the impact that wind-related hazards (e.g., falling trees/utility poles/wires) may have on critical infrastructure.

1.2 PARTICIPATING PERSONNEL

The key participating personnel in the development of the CAP were the District Superintendent, Operations staff, the District Board of Trustees, and Wright-Pierce. The CAP has been funded by Maine DEP and is subject to Maine DEP review and approval.

It is recommended that the results of the CAP report be shared with the District's local Emergency Management Agency and local municipal planning board for future planning and emergency/ natural disaster coordination purposes.

SECTION 2 EXISTING CONDITIONS

2.1 WATER POLLUTION CONTROL FACILITY

The District's owns and operates the Wells Sanitary District Water Pollution Control Facility (WWTF) located at 197 Eldridge Road in the Town of Wells, Maine (Figure 1). The WWTF is permitted to treat wastewater flows up to a peak hourly flow capacity of 2.0 million gallons per day (MGD) but is designed to handle a peak hourly flow of 5.0 MGD.

FIGURE 1 – WELLS SANITARY DISTRICT WWTF

All influent flow passes through a mechanical screen and then through a vortex grit system located in the WWTF headworks. The headworks effluent flows into a channel that regulates flow to the six aeration tanks. The WWTF uses the activated sludge process to treat incoming domestic waste. During the summer, all 6 aeration tanks remain online in either a Modified Ludzack-Ettinger (MLE) or parallel reactors configuration, depending on the specific treatment needs. The District uses only two aeration tanks for winter operation, with the remaining four tanks on stand-by. Figure 2 shows the WWTF process flow diagram including critical unit process components.

Only one of the two available 320,000-gallon secondary clarifiers is currently online. A second clarifier unit is available to be brought online during clarifier maintenance tasks and to eventually accommodate future projected peak sewer flows. Flow passes from the secondary clarifier to one of two chlorine contact tanks where sodium hypochlorite is added for disinfection based on flow and measured chlorine residual. Effluent is pumped through a 24-inch diameter force main to the outfall diffuser in the Atlantic Ocean (Figure 3). The outfall diffuser is equipped with four high-velocity ports with Duckbill™ check valves to prevent back flow of sea water into the outfall force main.

Sludge is dewatered by two parallel centrifuge dewatering units located in the Process Building. Centrate water from the centrifuge is returned to the aeration basins while dewatered sludge is conveyed to a roll-off container and then trucked to a landfill for disposal in Unity, Maine or is composted at Village Green in Brunswick, Maine. Typically, both centrifuge units are used for dewatering operations.

FIGURE 2 –WWTF PROCESS FLOW DIAGRAM

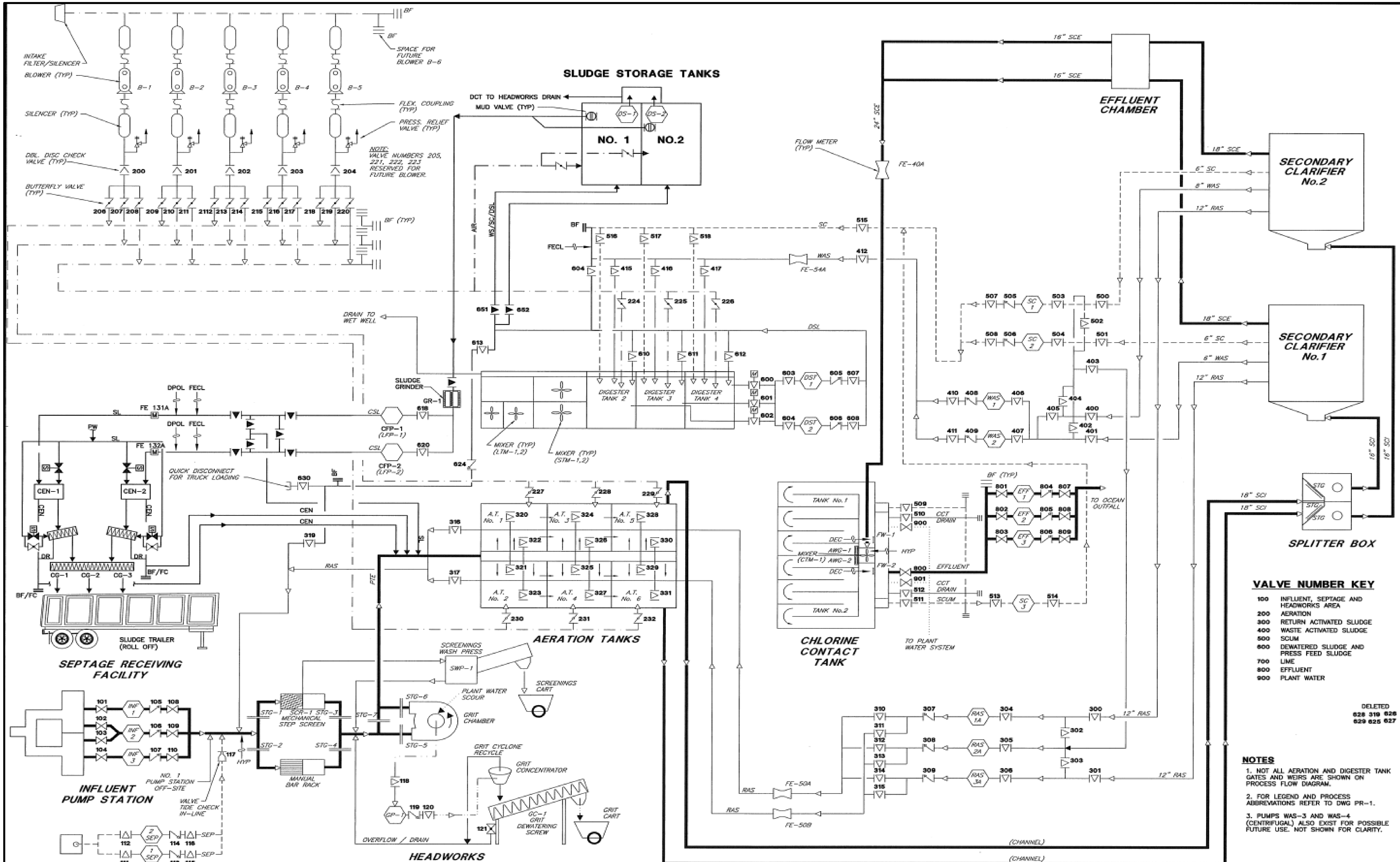
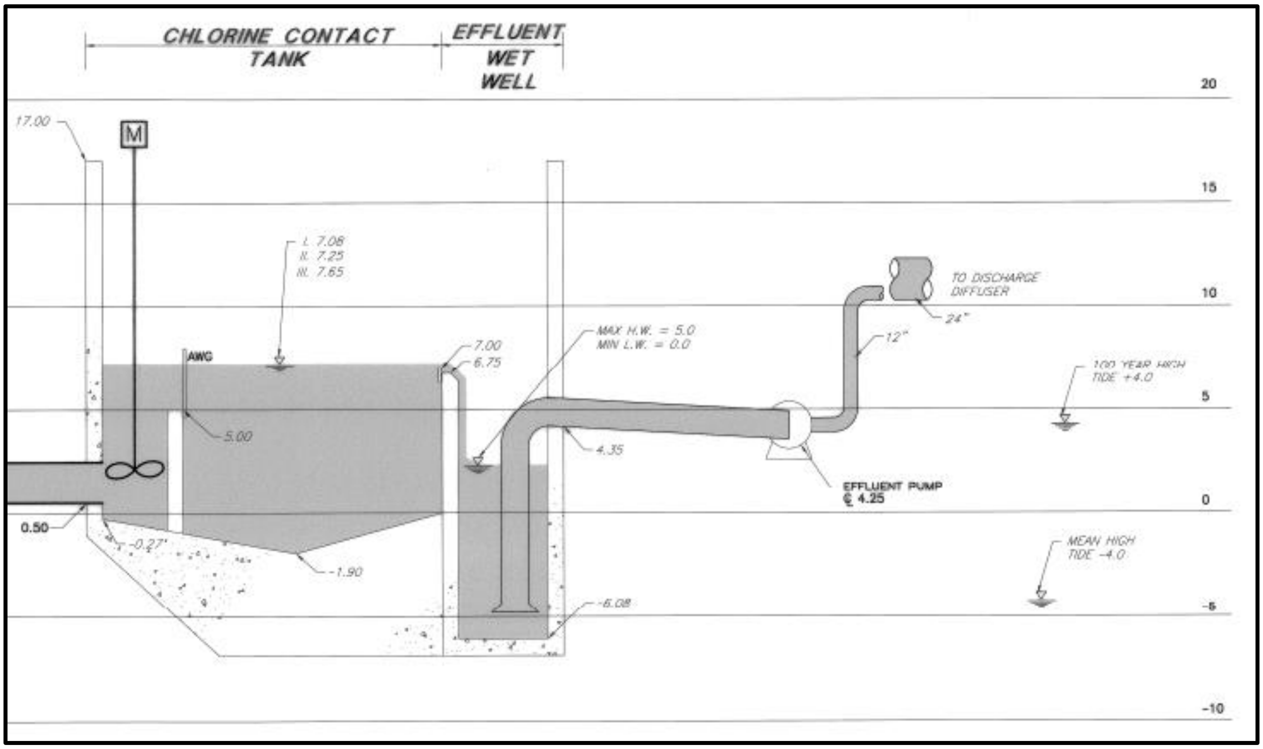


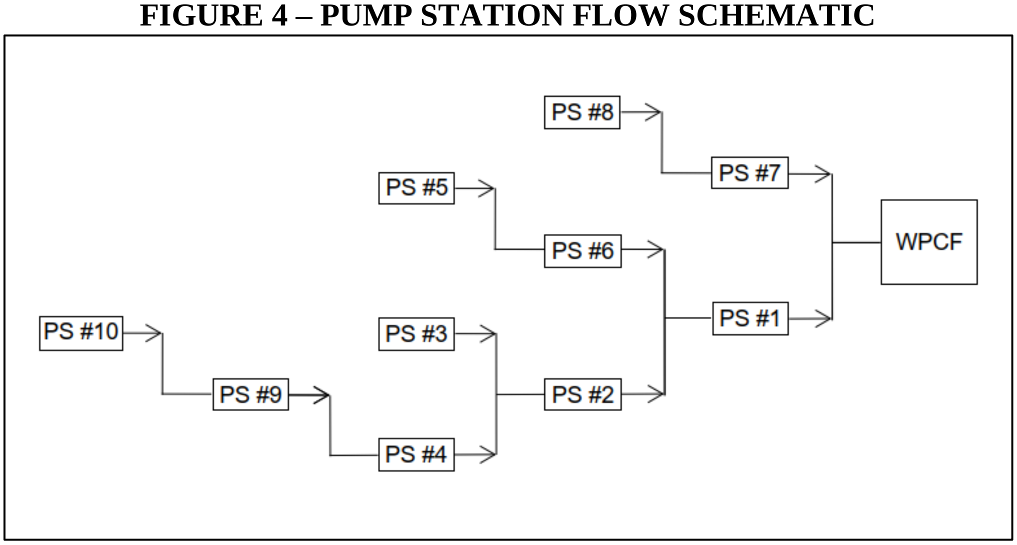
FIGURE 3 – PUMPED WWTF EFFLUENT OUTFALL



2.2 PUMP STATIONS

The sewer collection system has ten major wastewater pumping stations that convey wastewater to the WWTF for treatment. Figure 4 shows a schematic diagram of pump station flows to the WWTF. Figure 5 in Appendix A-1 shows the geographic locations and service areas of the ten major pump stations.

FIGURE 4 – PUMP STATION FLOW SCHEMATIC



Seven of the pump stations are flooded suction type stations with mechanical equipment located below-grade. Three of the stations (#5, #9 and #10) are suction-prime stations with mechanical equipment located above-ground. All the stations are equipped with audible and visual alarms and stand-by emergency generators. Several of the pump stations are located within the 100-floodplain.

Table 2-1 summarizes pump station attributes and Table 2-2 includes the elevations of pertinent pump station equipment and structures in relation to several floodplain scenarios discussed in further detail in Section 3, Evaluation of Climate Change Impacts.

TABLE 2-1
PUMP STATION ATTRIBUTES SUMMARY

Pump Station No.	Location	Pump Type	Pump Manufacturer	No. of Pumps	Rated Capacity (GPM)	Motor Size (HP)	Original Construction Date (Years)	Major Upgrade Date(s) (Years)	Connection to Utility Power	Emergency Power Source	Emergency Power Source Installation Date	Radio Telemetry Equipment?
PS-1	806 Ocean Avenue	Flooded-Suction	Fairbanks-Morse	3	1,625	40	1979	2005	Underground	Diesel Generator	1980	YES
PS-2	203 Webhannet Drive	Flooded-Suction	Fairbanks-Morse	3	1,350	30	1979	2005, 2016, 2018	Underground	Diesel Generator	1980	YES
PS-3	Lower Landing Road/ Harbor Rd	Flooded-Suction	Allis Chalmers	2	925	15	1979	--	Underground	Diesel Generator	1980	YES
PS-4	0 Island Beach Road	Flooded-Suction	Allis Chalmers	2	1,075	25	1979	2015	Underground	Diesel Generator	2015	YES
PS-5	120 Salt Marsh Circle	Suction-Prime	Gorman-Rupp	2	250	3	1997	--	Underground	Propane Generator	1997	YES
PS-6	249 Bourne Ave	Flooded-Suction	Fairbanks-Morse	2	865	15	1979	2017	Underground	Diesel Generator	1980	YES
PS-7	Post Rd. (Route 1)/ Buffum Hill Rd.	Flooded-Suction	Allis Chalmers	2	1,140	60	1979	--	Underground	Diesel Generator	2019	YES
PS-8	76 Mile Road	Flooded-Suction	Allis Chalmers	2	675	25	1979	--	Underground	Diesel Generator	1980	YES
PS-9	47 Kennebunkport Road (Route 9)	Suction-Prime	Gorman-Rupp	2	150	15	2000	--	Underground	Propane Engine	1999	YES
PS-10	Bypass Road	Suction-Prime	Gorman-Rupp	2	220	15	2007	--	Underground	Propane Engine	2006	YES

TABLE 2-2
PUMP STATION FLOOD ELEVATIONS

Pump Station Identification	Existing Grade Elevation (ft.)	Drywell Entrance Elevation (ft.)	Main Electrical Service Panel Elevation (ft.)	Emergency Generator Elevation (ft.)	FEMA 100-year BFE (ft.)	100-year BFE +2ft (ft.)	100-year BFE +3ft (ft.)	Cat. 1 Hurricane Storm Surge Elevation (SLOSH) (ft.)
PS-1	8.95	9.50	13.03	10.00	16.00	18.00	19.00	10.00
PS-2	5.85	9.25	10.01	9.75	14.00	16.00	17.00	10.00
PS-3	13.25	14.10	16.10	14.23	12.00	14.00	15.00	10.00
PS-4	9.45	10.71	12.54	11.21	12.00	14.00	15.00	10.00
PS-5	24.00	25.54	25.96	25.00	14.00	16.00	17.00	10.00
PS-6	9.35	10.72	12.39	10.51	14.00	16.00	17.00	10.00
PS-7	11.25	12.42	13.42	12.32	10.00	12.00	13.00	10.00
PS-8	12.25	13.59	15.76	14.88	15.00	17.00	18.00	10.00
PS-9	23.00	23.50	25.00	24.00	20.00	22.00	23.00	N/A
PS-10	43.50	44.00	45.58	44.50	24.00	26.00	27.00	N/A

Note: elevations in red indicate possible inundation under at least one flood scenario listed.

During a site inspection conducted on July 30, 2019, Wright-Pierce staff observed existing pump station conditions and identified possible climate change-related hazard vulnerabilities requiring further review. A summary of their findings at each station are summarized below.

Pump Station 1

- Pump station is located near wetland.
- Main power service panel is located outdoors about 49 inches above grade.
- Electrical conduit and panels appear to be original to the station construction. Not clear if they are NEMA-rated explosion proof and/or gas tight.
- Station has radio telemetry equipment located on top of pump station building.
- Large trees overhang east side of property.
- Pump station has 1-foot removable flood barriers for doors for both wetwell and drywell side building entrances

PUMP STATION 1

- It utilizes a 135kW indoor diesel stand-by power generator.
- There is an open aluminum grate in the floor on upper and intermediate levels for equipment removal that opens into each level below.
- HVAC ductwork penetrations into drywell floor do not appear to be watertight.
- VFD panels are original to the station construction and are located in intermediate level below grade on drywell side of pump station. Not clear if the panels are NEMA-rated explosion-proof.
- Pump motors located in intermediate level below grade on drywell side of pump station.

Pump Station 2

- Pump station is adjacent to salt marsh.
- Station has experienced historical flooding.
- Access road to station historically flooded.
- Main power panel is located on outside wall 51 inches feet above grade.

- Underground electrical feed experienced historical flooding. Main feed conduits were replaced and resealed in 2016.
- Station's electrical conduit and panels appear to be original to the station construction. Not clear if they are NEMA-rated explosion proof and/or gas tight.
- Station has radio telemetry equipment located on top of pump station building.

PUMP STATION 2

- Pump station has removable flood barriers for doors that protect against flooding to a height of 45 inches.
- Station has 135kW indoor diesel stand-by power generator on 6-inch concrete pad.
- Generator fuel tank is bolted to elevated concrete pad to prevent floating during flooding.
- There is an open aluminum grate in the floor on upper and intermediate levels for equipment removal that opens into each level below.
- HVAC ductwork penetrations into drywell floor do not appear to be watertight.
- VFD panels are original to the station construction and are located in intermediate level below grade on drywell side of pump station. Not clear if the panels are NEMA-rated explosion-proof.
- Pump motors located in intermediate level below grade on drywell side of pump station.

<u>Pump Station 3</u>

- Station is located near salt marsh but significantly elevated above it.
- Main electrical service fed from underground conduit.
- Electrical conduit penetrations in upper and intermediate levels are not sealed or watertight.
- Electrical conduit and panels appear to be original to the station construction. Not clear if they are NEMA-rated explosion proof and/or gas tight.

PUMP STATION 3

- Station has radio telemetry equipment located on top of pump station building.
- No visible leaks in wetwell tank and grout seal is in good condition.
- Main electrical power breaker panel located inside station structure about two feet above finished floor elevation.
- Building exterior was upgraded with a new concrete roof, covered with rubber membrane, repaired concrete corners, and wider door to accommodate removal of generator when replaced in the future.
- There is an open aluminum grate in the floor on upper and intermediate levels for equipment removal that opens into each level below.
- HVAC ductwork penetrations into drywell floor do not appear to be watertight.
- VFD panels located in intermediate level below grade on drywell side of pump station.
- Pump motors located in bottom floor below grade on drywell side of pump station.
- Station had sump pump located on bottom floor with pump motors.
- Station is equipped with back-up mechanical float switch for emergency override of local disconnect switch to shut-off of pump motors.

Pump Station 4

- Station is located near tidal river and salt marsh, but no historical flooding of the pump station has been observed by operators in the past 30 years.
- Local power transformer is located next to station on 12-inch concrete pad.
- Wetwell is very close to local transformer. Wetwell flooding and off-gassing could be a risk to transformer.
- Main power feed is from underground electrical conduit. Seals appear to be in good condition.
- Electrical conduit and panels appear to be original to the station construction. Not clear if they are NEMA-rated explosion proof and/or gas tight.

PUMP STATION 4

- Station is equipped with outdoor 80-kW diesel stand-by power generator installed in 2015 on a 6-inch concrete pad.
- Station has radio telemetry equipment located on top of pump station building.
- There is an open aluminum grate in the floor on upper and intermediate levels for equipment removal that opens into each level below.
- Electrical conduit and process piping penetrations into floor on upper and intermediate levels are not sealed or watertight.
- HVAC ductwork penetrations into drywell floor do not appear to be watertight.
- VFD panels located in intermediate level below grade on drywell side of pump station.
- Rust has formed on the top of the control box on the third intermediate level, possibly from water leaking down from upper levels through unsealed conduit penetrations.
- Station had sump pump located on bottom floor with pump motors.
- Station is equipped with back-up mechanical float switch for emergency override of local disconnect switch to shut-off of pump motors.

Pump Station 5

- Station is equipped with an indoor 15-kW stand-by propane generator inside a wooden shed.
- Generator is elevated about 1 foot from grade elevation.
- The generator is original to the pump station construction.
- Large trees overhang pump station property.
- No nearby waterbodies present.
- Adjacent property is part of federal wildlife refuge.
- Roof of pump station hut must be unbolted removed to perform routine pump maintenance tasks.

PUMP STATION 5

- Station has radio telemetry equipment located on top of the generator hut building.

Pump Station 6

- Station is located near tidal river and salt marsh. The station is within the 100-year floodplain.

- Wetwell structure is equipped with concrete wall 26 inches above grade to prevent flooding.
- Station building has removable wooden flood barriers for entrance door.
- Electrical conduit and panels appear to be original to the station construction. Not clear if they are NEMA-rated explosion proof and/or gas tight.
- Main power feed is from underground electrical conduit. Seals appear to be in good condition.
- The bottom of the main breaker panel in the pump station building is 20 inches above finished floor elevation.
- Station is equipped with an indoor 62-kW standby diesel power generator elevated 6 inches from finished floor elevation on the first floor of the generator building.

PUMP STATION 6

- The generator appears to be original to the station construction.
- Station has outdoor steel generator diesel fuel tank.
- Top of the generator skid is 6 inches from the finished floor elevation of the pump station building's first floor.
- There is an open aluminum grate in the floor on upper and intermediate levels for equipment removal that opens into each level below.
- Electrical conduit and process piping penetrations into floor on upper and intermediate levels are not sealed or watertight.
- HVAC ductwork penetrations into drywell floor do not appear to be watertight.
- VFD panels located in intermediate level below grade on drywell side of pump station.
- Station has radio telemetry equipment located on top of pump station building.
- Station had sump pump located on bottom floor with pump motors.
- Station is equipped with back-up mechanical float switch for emergency override of local disconnect switch to shut-off of pump motors.

Pump Station 7

- Station has historically had issues with spring runoff water flowing through the site. Road drainage improvements and a concrete retaining wall have been installed around the upslope area adjacent to the outdoor diesel generator to help redirect runoff away from the station.
- Station is equipped with a 100-kW outdoor diesel standby generator with an integral fuel tank.
- Generator equipment pad is elevated 7 inches above grade.
- Electrical conduit and panels appear to be original to the station construction. Not clear if they are NEMA-rated explosion proof and/or gas tight.
- Main power feed is from underground electrical conduit. Seals appear to be in good condition.

PUMP STATION 7

- The bottom of the main breaker panel in the pump station building is 13 inches above finished floor elevation.
- There is an open aluminum grate in the floor on upper and intermediate levels for equipment removal that opens into each level below.
- Electrical conduit and process piping penetrations into floor on upper and intermediate levels are not sealed or watertight.
- VFD panels located in intermediate level below grade on drywell side of pump station.
- Station has radio telemetry equipment located on top of pump station building.
- Station had sump pump located on bottom floor with pump motors.
- Station is equipped with back-up mechanical float switch for emergency override of local disconnect switch to shut-off of pump motors.

Pump Station 8

- Station is equipped with a 62-kW indoor diesel standby generator.
- The generator appears to be original to the station construction.
- Station has outdoor cast iron generator diesel fuel tank on concrete equipment pad elevated 9 inches above grade.

- Generator equipment pad is elevated 6 inches above grade.
- Electrical conduit and panels appear to be original to the station construction. Not clear if they are NEMA-rated explosion proof and/or gas tight.
- Main power feed is from underground electrical conduit. Seals appear to be in good condition.
- The bottom of the main breaker panel in the pump station building is 26 inches above finished floor elevation.
- There is an open aluminum grate in the floor on upper and intermediate levels for equipment removal that opens into each level below.

PUMP STATION 8

- Electrical conduit and process piping penetrations into floor on upper and intermediate levels are not sealed or watertight.
- VFD panels located in intermediate level below grade on drywell side of pump station.
- Station has radio telemetry equipment located on top of pump station building.
- Station has sump pump located on bottom floor with pump motors.
- Station is equipped with back-up mechanical float switch for emergency override of local disconnect switch to shut-off of pump motors.

<u>Pump Station 9</u>

- Main power feed is from underground electrical conduit. Seals appear to be in good condition.
- The bottom of the main breaker panel in the pump station building is 22 inches above finished floor elevation.
- Station has radio telemetry equipment located on top of pump station building.
- Station is equipped with propane-driven standby power engine located in the pump station building.

PUMP STATION 9

- The standby power engine's propane tank is located outdoors and is elevated on concrete cinder blocks.

- The station is located near the Merriland River and is within the river's 100-year floodplain. No historical flooding at the pump station has been observed.
- District staff believe the station building exhaust louvers are undersized, due to high temperatures in the station building during summer months.
- Internal heat from pump control panel has historically led to overheating of controls and alarm circuitry during hottest days of the year.

<u>Pump Station 10</u>

- Main power feed is from underground electrical conduit. Seals appear to be in good condition.
- The bottom the main breaker panel in the pump station building is 12 inches above finished floor elevation.
- Station is equipped with propane-driven standby power engine located in the pump station building.
- The standby power engine's propane tank is located outdoors and is at grade.

PUMP STATION 10

- Station has radio telemetry equipment located on top of pump station building.
- District staff believe the station building exhaust louvers are undersized, due to high temperatures in the station building during summer months.
- Internal heat from pump control panel has historically led to overheating of controls and alarm circuitry during hottest days of the year.
- Large pine trees adjacent to the station property present a blow-down risk to the station building.
- The station is equipped with an indoor well and well pumps for process wash down water.

2.3 COLLECTION SYSTEM

Wastewater is conveyed to the WWTF by a mix of low-pressure force main pipes and gravity sewers. The collection system is 42 miles in length and includes ten major pumping stations. Several privately-owned wastewater pump stations also convey wastewater flows from private residences and businesses to the District's sewer collection system. The District's sanitary sewer system is completely separated from the Town of Wells' existing stormwater infrastructure. There are no significant industrial users within the collection system contributing to wastewater flows.

The collection system pipes and manholes are relatively new and in good condition, showing little sign of rainfall-induced inflow and infiltration. The majority of the gravity collection system pipes are PVC with larger interceptor pipes made of reinforced concrete. Most of the collection system's inflow comes from leakage between the manhole frames and covers in low-lying areas prone to flooding and/or stormwater ponding.

The local Sewer Use Ordinance prohibits direct connections of stormwater sources to the sanitary sewer system such as sump pumps, roof drains and foundation drains. It is still likely that a small number of these private inflow sources are connected to the sanitary sewer, as is typical of most public sewer collection systems, however they do not to appear to be contributing a significant amount of inflow to the sanitary sewer system.

Figure 6 in Appendix A-2 depicts the sewer collection system main lines, interceptor sewers, the District's major pump stations and significantly sized private pump stations connected to the sewer system.

Several areas of the collection system appear to be located within the FEMA 100-year floodplain or are in low-lying areas. District staff also observed one occasion when the anchors on the discharge force main from Pump Station 4, located at the bottom of the Webhannet River, failed causing the discharge force main to float. The anchors were replaced, and the force main connections have since been repaired. The conditions of the existing submerged force main anchors were not evaluated as part of this study.

SECTION 3
EVALUATION OF CLIMATE CHANGE IMPACTS

3.1 POTENTIAL CLIMATE CHANGE IMPACTS

Climate change is a term that refers to a change in the average weather conditions or the time variation of weather patterns within a defined geographic region. Climate changes can have negative impacts on service utilities and should be considered as part of a utility's long-term planning process. Climate change can have amplified effects in certain geographic regions, depending on the region's topography, proximity to waterbodies and typical meteorological conditions. The first step in considering the potential impacts of climate change on a utility is to determine which impacts are most applicable to the utility's geographic region. Potential climate change impacts and the associated hazards applicable to the District's assets and personnel were identified in Table 3-1 at the end of this section.

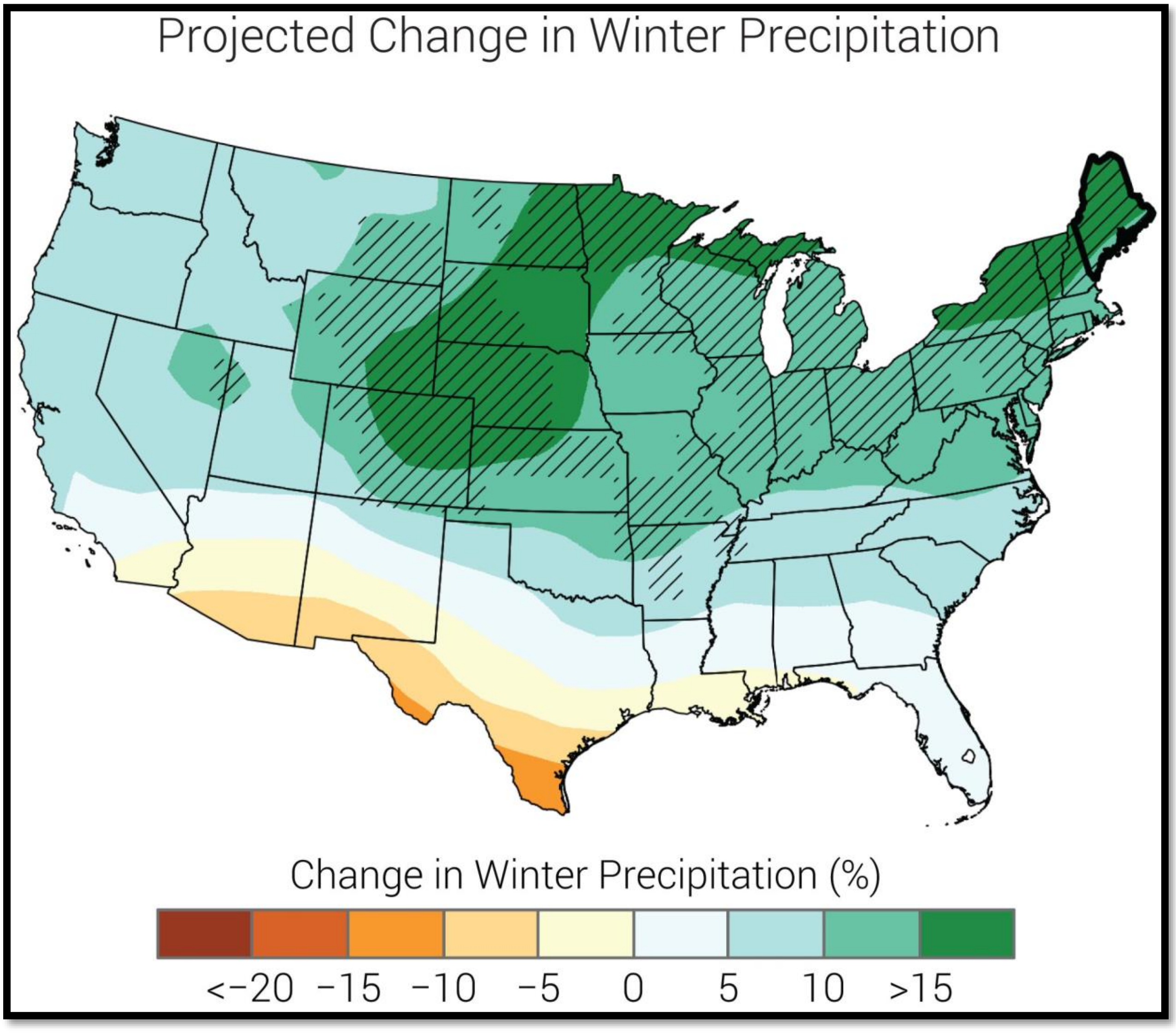
Utility climate adaptation planning should also consider how climate change may affect future service capacity needs and a utility's ability to meet them. According to projections prepared by the State of Maine Office of Policy and Management, the Town of Wells is projected to see high population growth over the 20-year planning horizon (+21.2%, 2016-2036)[1]. The District's wastewater treatment facility has been sized to provide adequate capacity to accommodate the projected population growth expected over the 20-year planning period. The facility is currently licensed to treat an average daily flow of 2.0 MGD but it has been designed to handle a peak flow of 5.0 MGD.

The District does not have a combined stormwater/sanitary sewer system or experience regular inflow or infiltration into the sewer system to a level that would significantly limit sewer pipe capacities. Without specific inflow and infiltration (I/I) rates from flow metering, it would be difficult to determine if additional I/I from changing precipitation patterns will have a significant impact on collection system capacity. In general, it is assumed that more intense and/or prolonged storm events will increase rainfall-induced inflow and infiltration volume into the sewers over time

[1] State of Maine Office of Policy and Management, https://www.maine.gov/dafs/economist/demographic-projections

as the system ages. This would translate to reductions in the effective capacity of the sewers during these periods. Figure 7 shows the projected changes in total annual winter precipitation across the country. The figure indicates that the Wells area is expected to see a 10-15% increase in winter precipitation by the latter half of the century.

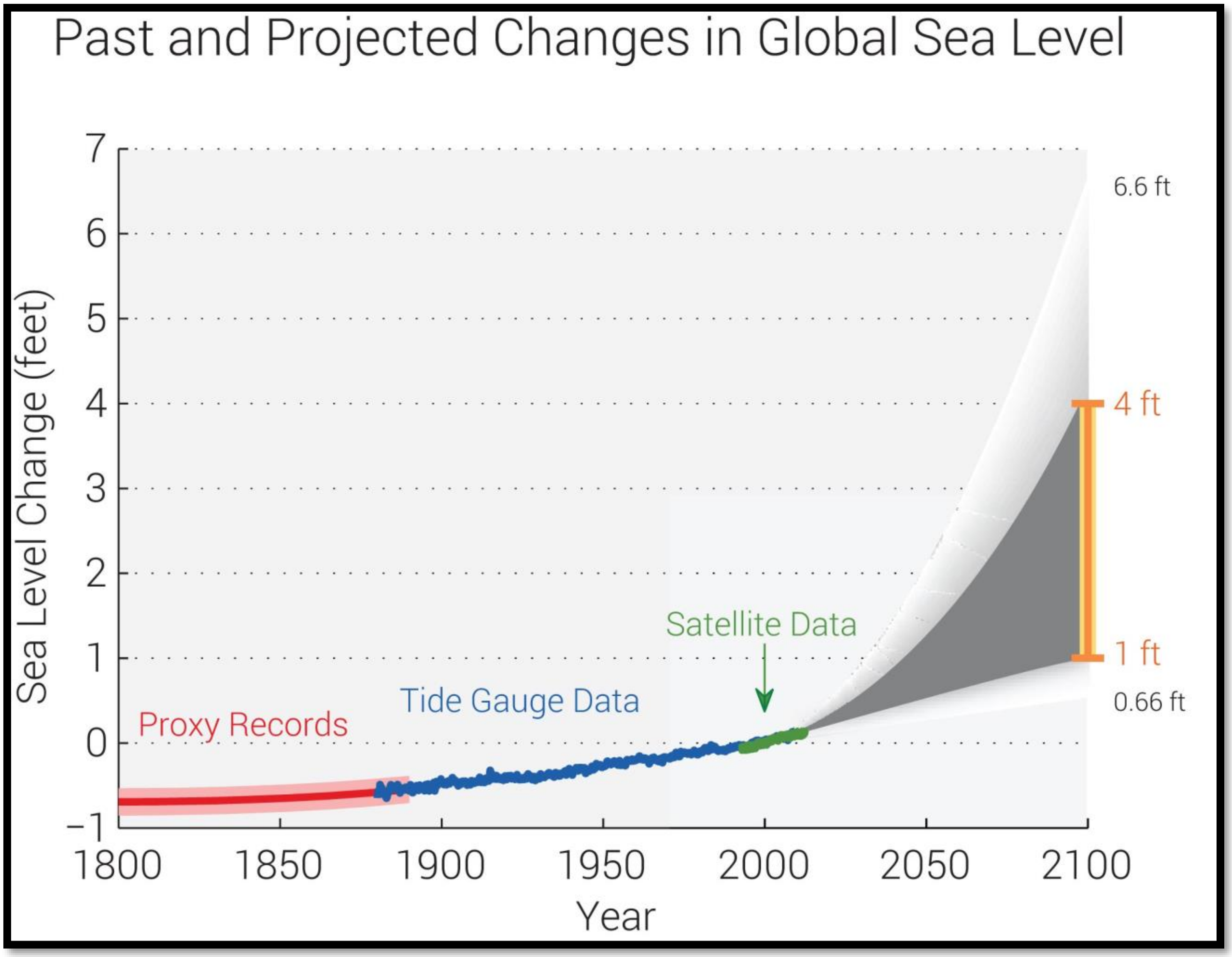
FIGURE 7 – PROJECTED WINTER PRECIPITATION CHANGES



Source: CICS-NC and NOAA NCEI

Climate change may also cause or contribute to sea level rise and marsh migration along Maine's coast. NOAA climatology models have been used to simulate a range of climate change scenarios including the expected magnitude of sea level rise (Figure 8). The orange line at right in Figure 8 shows the most likely range of 1 to 4 feet by 2100 based on an assessment of scientific studies, which falls within a larger possible range of 0.66 feet to 6.6 feet[2].

FIGURE 8 – NOAA SEA LEVEL RISE SCENARIOS

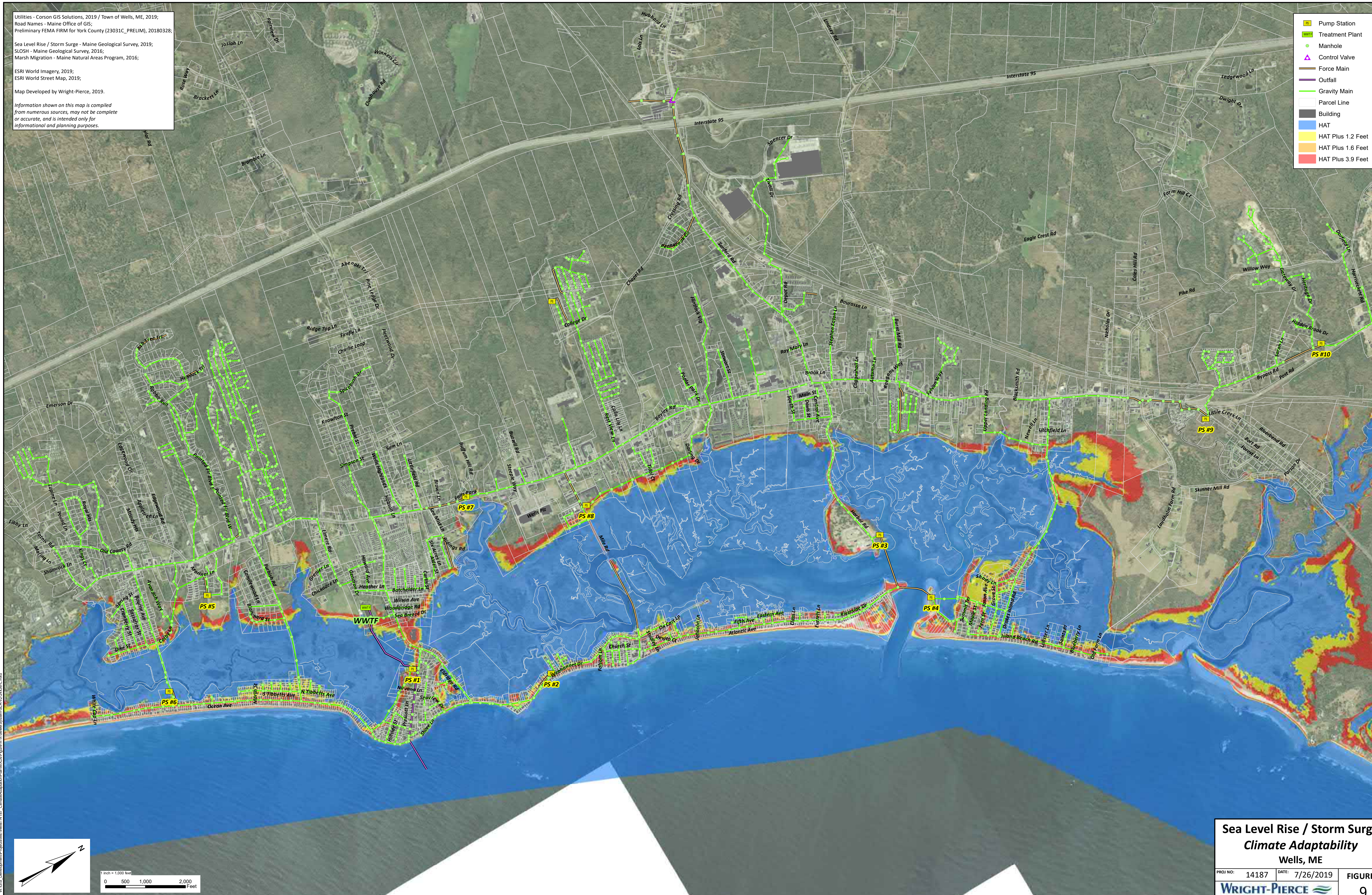


Source: Mellilo et al. 2014 and Parris et al. 2012.

The Maine Geological Survey has used long-term sea level rise data from several monitoring locations along Maine's coast, the U.S. Army Corps of Engineers Sea-Level Change Curve

[2] Runkle, J., K. Kunkel, S. Champion, R. Frankson, B. Stewart, and A.T. DeGaetano, 2017: Maine State Climate Summary. NOAA Technical Report NESDIS 149-ME, 4 pp.

Calculator, NOAA climatology models and LiDAR topographic data to create GIS layers that simulate the extent of coastal inundation and marsh migration during highest astronomical tide (HAT), accounting for possible flood elevation increases from sea level rise or storm surge. GIS layers were obtained from Maine Geological Survey and superimposed on the District's GIS information layers to simulate possible flooding and marsh migration threats. Figure 9 includes the regional HAT elevations and 1.2, 1.6 and 3.9 feet of sea level rise or storm surge above the HAT elevation. Figure 10 shows possible tidal marsh migration from 1, 2, and 3.3 feet of sea level rise.



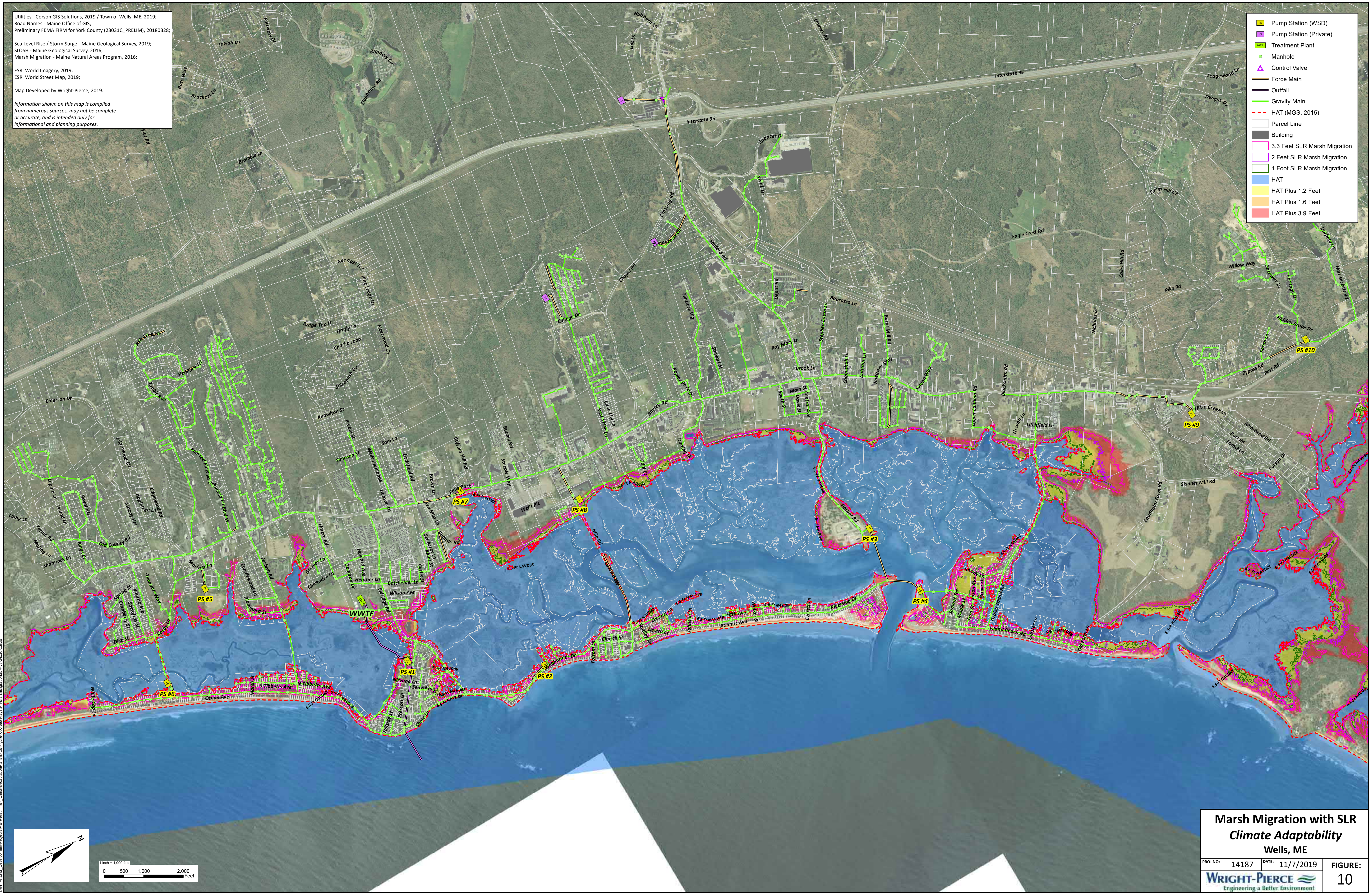
Sea Level Rise / Storm Surge

Climate Adaptability

Wells, ME

PROJ NO: 14187 DATE: 7/26/2019 FIGURE: 9

WRIGHT-PIERCE
Engineering a Better Environment



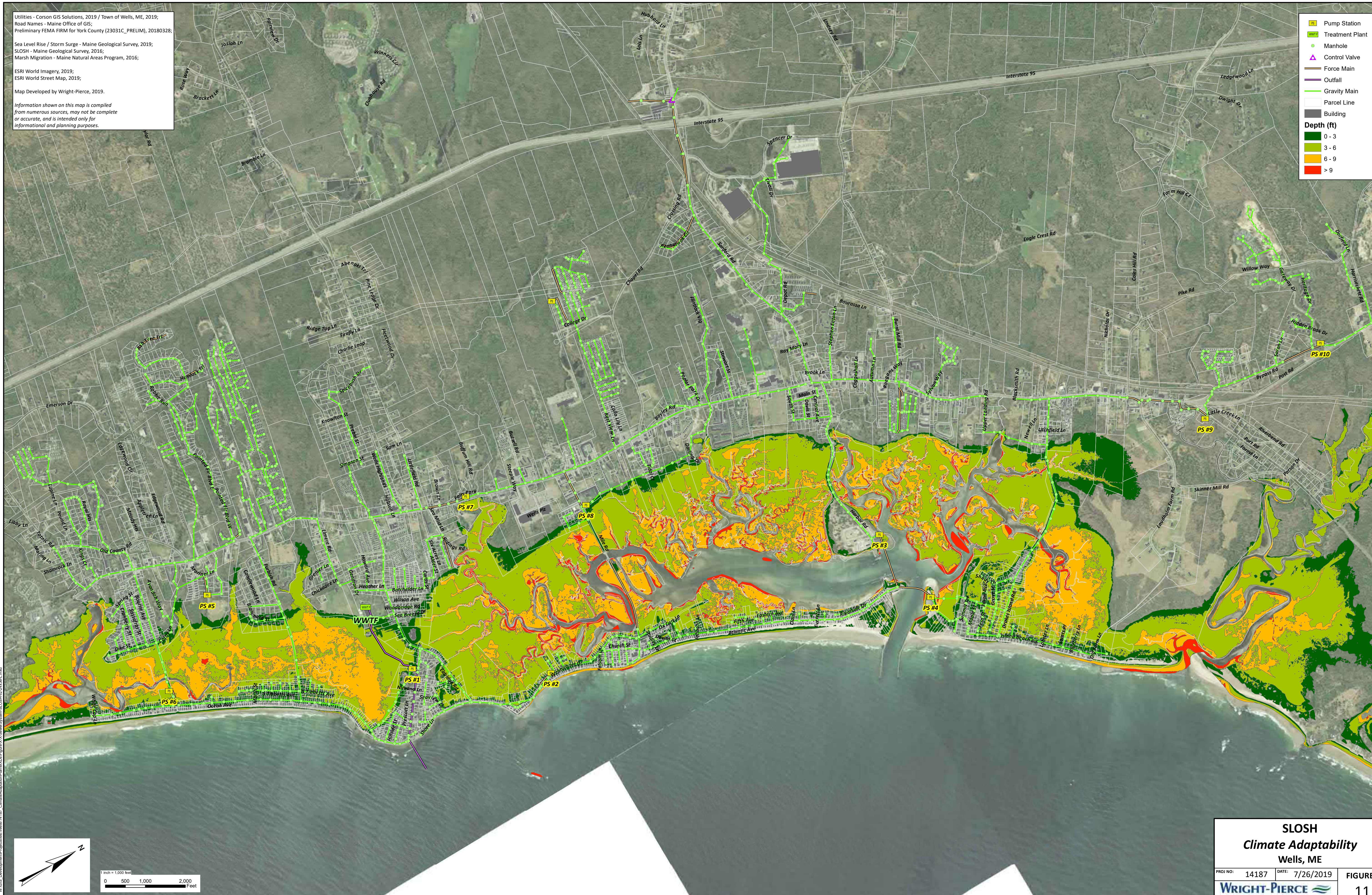
Marsh Migration with SLR
Climate Adaptability
Wells, ME

PROJ NO: 14187 | DATE: 11/7/2019 | FIGURE: 10

WRIGHT-PIERCE
Engineering a Better Environment

The Maine Geological Survey has used its Sea, Lake and Overland Surges from Hurricanes (SLOSH) computer model and topographic data to simulate potential flooding from Category 1, 2, 3 and 4 hurricane scenarios along Maine's coast during mean high tide conditions. Based on the historical record, the District has only experienced one major hurricane off its coast in the last 100 years (1954) and several tropical storms of note that have caused major flooding and property damage. However, increased warming of Maine coastal waters over time could sustain or intensify tropical storms that hit the Maine coast, increasing the likelihood of flooding and property damage. A SLOSH model GIS layer for a Category 1 hurricane hitting the region during mean high tide was obtained from the Maine Geological Survey's SLOSH simulation dataset and superimposed onto the District's wastewater GIS layers to help assess the potential threat to the District's wastewater infrastructure (Figure 11).

Individual GIS figures for each of the District's major pump stations and WWTF including sea level rise, highest annual tide, storm surge, marsh migration and SLOSH model layers for a Category 1 hurricane are included in Appendix B.



SLOSH

Climate Adaptability

Wells, ME

PROJ NO: 14187 | DATE: 7/26/2019 | FIGURE: 11

WRIGHT-PIERCE
Engineering a Better Environment

3.2 HAZARD RISK ASSESSMENT

One of the CAP goals is to assess how climate change hazards could impact the District's ability to reliably serve its customers, meet regulatory obligations and provide a safe working environment for its staff. Potential hazard vulnerabilities and possible consequences for the entire wastewater collection and treatment system and specific assets were identified during site inspections of the District's critical infrastructure and a review of the District's existing plans, studies and GIS data. Potential hazard consequences and their impact on the associated assets were assessed to determine their likelihood of occurring and to help prioritize adaptation measures.

Critical system components were established by the District based on their importance to achieving the District's goals of reliably serving its customers, meeting regulatory obligations, and providing a safe working environment for the District staff. Critical components included the WWTF, 10 major pump stations and sewer collection system main lines. Tables 3-2, 3-3, 3-4, and 3-5 at the end of this section summarize the identified hazard vulnerabilities, possible consequences, and the risk assessment findings for the entire wastewater collection and treatment system, WWTF, pump stations, and collection system sewers, respectively.

TABLE 3-1
CLIMATE CHANGE IMPACTS & POTENTIAL HAZARDS

Climate Change Impact	Potential Hazards	Hazard Description	Applicability
Increased Flood Risk	Riverine Flooding	Flooding of the land adjacent to the banks of rivers and streams because of precipitation, snow melt or a combination of both. Flooding can cause catastrophic damage to equipment and structures, render critical assets temporarily inaccessible and impact emergency response time.	Several of the major pump stations are located near rivers and/or large streams increasing their vulnerability to riverine flooding. Major access roads to portions of the collection system may also be vulnerable to riverine flooding given their proximity to rivers and streams.
	Flash Flooding	Flooding that begins within 6 hours of heavy rainfall or other causes (e.g., dam or levee breach). Flooding can cause catastrophic damage to equipment and structures, render critical assets temporarily inaccessible and impact emergency response time. Flash flooding can be a greater risk for urban areas because of the increased percentage of impervious ground cover and for low-lying areas without storm water infrastructure.	Flash flooding in the Wells area is likely to be caused by large thunderstorms, tropical storms and hurricanes, with the greatest risk to urban areas (more impermeable surfaces) and low-lying areas without storm water infrastructure. Critical assets located in areas at greater risk for flash flooding will be evaluated.
	Coastal Flooding	Flooding of the land adjacent to the ocean and estuarine areas. Flooding can cause catastrophic damage to equipment and structures, rendering critical assets temporarily inaccessible and impact emergency response time. Salt from brackish water can corrode metals and cause severe equipment damage.	Several of the District's critical assets are located on land adjacent to the Atlantic Ocean and salt water marsh, making coastal flooding a potential risk that warrants further hazard evaluation.
	Sea Level Rise	Increase in the average elevation of coastal waters. Sea level rise can change the coastal topography and destabilize coastal soils. It can also enhance other climatic hazards (e.g., coastal flooding, storm surge, marsh migration slope destabilization).	More than half of the District's major pump stations and a significant portion of the interceptor sewers are located on land adjacent to the Atlantic Ocean or salt water marsh, making sea level rise a potential risk that warrants further hazard evaluation.
Precipitation Changes	Excessive Precipitation	Precipitation magnitude and/or frequency that produces extended periods of saturated ground conditions and can lead to secondary hazards (e.g., flooding, poor travel conditions, power outages, SSOs, accessibility issues, soil erosion, slope destabilization).	Excessive precipitation could potentially impact all the District's critical assets and warrants further hazard evaluation.
Storm Characteristics	Increased Storm Intensity	Storm intensity is a measure of precipitation magnitude over a period of time. As storm intensity increases, greater magnitudes of rainfall occur over a specific period of time. This can lead to secondary hazards (e.g., flooding, storm surge, poor travel conditions, power and communication systems outages, SSOs, accessibility issues, WWTF operational issues, slope destabilization).	Secondary hazards associated with increased storm intensity could significantly impact several the District's critical assets and operational procedures.
	Increased Storm Duration	Storm duration is the amount of time elapsed between the start and end of precipitation. An increase in average storm duration could lead to secondary hazards (e.g., flooding, poor travel conditions, power outages, SSOs, accessibility issues, WWTF operational issues)	Secondary hazards such as power outages and flooding from increased storm duration could affect system reliability and operational procedures.
	Increased Storm Frequency	Storm frequency is a measure of the period of time between each storm event. As storms become more frequent, secondary hazard conditions (e.g., flooding, poor travel conditions, power and communication systems outages, SSOs, accessibility issues, WWTF operational issues) occur more frequently or may be exacerbated.	Increased storm frequency could potentially cause issues at several of the District's critical assets that are prone to flooding and affect typical operational procedures.
Wind-related Impacts	Excessive Wind Speeds	Excessive wind speeds can result in direct damage to buildings, enclosures or equipment exposed to the outdoors, can lead to secondary hazards from downed trees, utility poles and power lines (e.g., dangerous working conditions, structural damage, power and communication systems outages, accessibility issues) and can potentially cause operational issues.	Critical assets that are directly exposed to the outdoors, located near trees, utility poles and/or power lines and electrically-operated equipment may be impacted by excessive wind speeds, as well as typical operational procedures.

TABLE 3-2
SYSTEM-WIDE VULNERABILITIES

Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
Excessive Precipitation	• Water leaks into enclosures, electrical equipment and conduits • Poor travel conditions • Utility power outages • Hazardous working conditions • Increased snow loading to enclosures • Accessibility issues from excess snowfall	• All system components exposed to the outdoors have been constructed to be weather resistant. Water leaks from precipitation alone are not expected to have a significant impact. • Poor travel conditions would be limited to relatively large and infrequent storms or hurricanes. • Utility power outages would impact the function of electrical and mechanical equipment. Most of the District's critical assets depend on electrical and mechanical components to function and would be negatively impacted by utility power loss. The District has emergency stand-by power supply provisions at the WWTF and all 10 major pump stations to mitigate the effects of a utility power loss. • The collection system, pump stations and WWTF experience high wet-weather flows. Increased wet-weather flows could accelerate wear on system components and impact operational procedures and treatment. • Existing enclosures that do not meet updated snow loading codes may be at greater risk for structural failure as they age. • Increased snowfall could impact accessibility to the collection system and pump stations.
Increased Storm Intensity, Duration & Frequency	• Localized flooding or ponding • Soil erosion • Water leaks into enclosures, electrical equipment and conduits • Poor travel conditions • Utility power outages • Hazardous working conditions • Increased I/I to collection system, pump stations and WWTF	• Localized flooding or ponding would be limited to periods of saturated soil conditions in areas with poor drainage. Localized flooding could temporarily inhibit access to some pump stations. However, the pump stations have radio telemetry systems to notify staff in the event of equipment failure and stand-by power supplies to mitigate the risk of equipment failure during a utility power loss. • Soil erosion would be limited to areas with steep topography or little to no vegetative cover. No system components are in areas expected to be impacted by significant soil erosion. • All system components exposed to the outdoors have been constructed to be weather resistant. Water leaks from precipitation alone are not expected to have a significant impact. Flooding from large and infrequent storms and hurricanes could negatively impact outdoor electrical equipment and conduits if they become submerged. • Poor travel conditions would be limited to relatively large and infrequent storms, blizzards and hurricanes. District staff are not expected to travel during extremely hazardous travel conditions. • Utility power outages would impact the function of electrical and mechanical equipment. Most of the District's critical assets depend on electrical and mechanical components to function and would be negatively impacted by utility power loss. The District has emergency stand-by power supply provisions and radio telemetry equipment at the WWTF and all 10 major pump stations to mitigate the risk of equipment failure during a loss of utility power. • Working outdoors during heavy rain or snowfall conditions increases the risk of slips, trips and falls. Frost-bite and hypothermia is also a risk during freezing conditions. • The wastewater collection and treatment system in general is not currently experiencing excessive I/I levels. It is assumed that the wastewater collection and treatment system could accommodate additional I/I resulting from climate change.

Excessive Wind Speeds	• Utility power outages • Increased wind loading to enclosures and panels	• Utility power outages would impact the function of electrical and mechanical equipment. Most of the District's critical assets depend on electrical and mechanical components to function and would be negatively impacted by utility power loss. The District has emergency stand-by power supply provisions and radio telemetry equipment at the WWTF and all 10 major pump stations to mitigate the risk of equipment failure during a loss of utility power. • All enclosures and panels were rated to meet local code for wind loading at the time of their construction. It is not clear if all enclosures would meet current local code for wind loading.

TABLE 3-3
WWTF VULERNABILITIES

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
Grit Pump	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The loading dock entrance to the Lower Headworks is at the 100-year FEMA flood elevation of 14 feet. The grit pump is located below this elevation putting it at risk for flooding during a 100-year flood event. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Return Activated Sludge (RAS) Pumps	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• RAS pumps are located in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the RAS pumps could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Waste Activated Sludge (WAS) Pumps	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• WAS pumps are located in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the WAS pumps could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Dewatering Feed Pumps	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• Dewatering equipment feed pumps are in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the feed pumps could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Dewatering Centrifuges	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The dewatering centrifuges are located in Dewatering Room on the Upper Floor of the Operations Building three feet above the 100-year flood elevation. This is three feet above the current 100-year flood elevation of 14 feet. Therefore, the risk of flooding in the Dewatering Room would be very unlikely. However, sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
Aeration System Blowers	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The aeration system blowers are in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the feed pumps could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of blower failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Effluent Pumps	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The effluent pumps are in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the effluent pumps could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Plant Water System	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The package plant water system is in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the plant water system could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of plant water system equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Scum Pumps	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The scum pumps are in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the scum pumps could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Flow Meter	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The plant flow meter is in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the flow meter could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of meter failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Chlorine Contact Chamber	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding	• WWTF flooding causing equipment failure and/or damage.	• The chlorine contact chamber is located on the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the chlorine contact chamber could also become inundated, leading to disinfection treatment process and equipment failure and possible permit

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
	• Sea Level Rise • Excessive Wind Speeds	• Utility power outages causing equipment failure.	violations. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of chlorine contact chamber process equipment failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Sludge Conditioning Mixer	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The sludge conditioning tank mixer is in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the mixer could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of mixer failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
Chemical Feed Pumps	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The plant's chemical feed pumps are in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the chemical feed pumps could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • Risk of pump failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
HVAC System	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• The plant's boiler and heating system equipment are in the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, the WWTF boiler and heating system could fail and be damaged by flood waters. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. A heating system failure could lead to secondary hazards such as process and chemical feed pipes freezing. • Risk of heating system failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.
WWTF Electrical Support Systems	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Excessive Wind Speeds	• WWTF flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure.	• A significant amount of electrical equipment and conduit is located on the Lower Floor of the Operations Building below the 100-year flood elevation. If the Operations Building's Lower Floor flooded, this electrical equipment could become submerged and fail and/or be damaged. Sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. • The finished floor elevation of Electrical Room 2, Electrical Room 2A and Electrical Room 3 is approximately 17 feet. This is 3 feet above the current 100-year flood elevation of 14 feet. Therefore, the risk of flooding in these rooms would be unlikely. However, sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation.

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
			• The main power feed transformer for the WWTF is located on the WWTF property the near the south entrance of the Operations Building. The transformer is located on a 6-inch concrete pad and ground elevation in this area is approximately 15 feet, so it is assumed that the transformer is located about 1.5 feet above the 100-year flood elevation. This is less than the recommended 3 feet above the 100-year flood elevation for critical electrical equipment (TR-16). • Risk of electrical systems failure from utility power outages is mitigated by the WWTF's stand-by emergency power generator.

TABLE 3-4
PUMP STATION VULNERABILITIES

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
Pump Station 1	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Marsh Migration • Excessive Wind Speeds	• Pump station flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure. • Downed trees causing structural or equipment damage. • Wetland encroachment on pump station site. • Accessibility issues from flood waters encroaching on access roads.	• The main electrical service, pump control and VFD panels, the stand-by generator and its intake louver are all below the 100-year floodplain elevation of 16 feet. The finished floor elevation of the upper level of the pump station is at elevation 9.5 feet. Flooding would be somewhat mitigated by the existing 1-ft removable flood doors for both the wetwell and drywell side entrances, but the top elevation of 1-ft barriers (10.5 ft) is still below 100-year floodplain elevation. A 100-year flood event could pose a significant risk to the pump station's electrical and mechanical equipment. Sea level rise will further increase the station's risk of flooding during large storm events. No historical flood encroachment observed at the pump station by operations staff. • Risk of equipment failure from utility power outages is mitigated by the station's stand-by power generator. • A few large trees on the adjacent property do overhang the pump station property and could pose a future blow down risk to the pump station structure. • Station property abuts wetland area that is part of a larger tidal marsh. It appears that sea level rise could cause marsh migration onto the pump station property. Refer to Figure PS#1-C in Appendix B-3. • It appears that the pump station's access routes could become inundated during the 100-year flood event or a Category 1 hurricane, temporarily inhibiting access to the pump station.
Pump Station 2	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Marsh Migration	• Pump station flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure. • Wetland encroachment on pump station site.	• The main electrical service, pump control and VFD panels, the stand-by generator and its intake louver are all below the 100-year floodplain elevation of 14 feet. Flooding is somewhat mitigated by the existing 4-ft removable flood doors for both the wetwell and drywell side entrances, but the top elevation of the 4-ft barriers (13.25 ft) is still below 100-year floodplain elevation. A 100-year flood event could pose a significant risk to the pump station's electrical and mechanical equipment. Sea level rise will further increase the station's risk of flooding during large storm events. Historical flooding

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
	• Excessive Wind Speeds	• Accessibility issues from flood waters encroaching on access roads.	has been observed by staff at the station. Flood waters reached above the first-floor elevation, but below the removable flood barrier elevation. • Risk of equipment failure from utility power outages is mitigated by the station's stand-by power generator. • Station property abuts wetland area that is part of a larger tidal marsh. It appears that sea level rise could cause marsh migration onto the pump station property. Refer to Figure PS#2-C in Appendix B-3. • It appears that the pump station's access routes could become inundated during the 100-year flood event or a Category 1 hurricane, temporarily inhibiting access to the pump station.

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
Pump Station 3	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Marsh Migration • Excessive Wind Speeds	• Pump station flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure. • Wetland encroachment on pump station site. • Accessibility issues from flood waters encroaching on access roads.	• The pump station drywell finish floor and standby generator elevations are above the current 100-year flood elevation, but below the NEIWPCC TR-16 recommended height for critical equipment (three feet above the 100-year flood elevation). The main electrical service panel is 3+ feet above the 100-year flood elevation. 2+ feet of sea level rise could effectively raise the 100-year flood elevation at the station above the ground-floor finished floor elevation, potentially putting the below-grade pump VFD panels and pump motors at risk of flooding. No historical flood encroachment has been observed at the pump station by operations staff. • Risk of equipment failure from utility power outages is mitigated by the station's stand-by power generator. • Station property abuts wetland area that is part of a larger tidal marsh. However, the station is somewhat elevated from the marsh area. Maine Geological Survey model data indicate that marsh migration from sea level rise is not likely to be a threat to the station. Refer to Figure PS#3-C in Appendix B-3. • It appears that the pump station's access routes could become inundated during the 100-year flood event or a Category 1 hurricane, temporarily inhibiting access to the pump station.
Pump Station 4	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Soil Erosion • Excessive Wind Speeds	• Pump station flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure. • Wetland encroachment on pump station site. • Accessibility issues from flood waters encroaching on access roads. • Beach encroachment on pump station property.	• The main electrical service, local electrical transformer, pump controls, VFD panels, and the stand-by generator are all below the 100-year floodplain elevation. A 100-year flood event could pose a significant risk to the pump station's electrical and mechanical equipment. Sea level rise will further increase the station's risk of flooding during large storm events. No historical flood encroachment observed at the pump station by operations staff. • Risk of equipment failure from utility power outages is mitigated by the station's stand-by power generator. • Station property abuts wetland area that is part of a larger tidal marsh. It appears that sea level rise greater than 3 feet could cause marsh migration onto the pump station property. Refer to Figure PS#4-C in Appendix B-3. • It appears that the pump station's access routes could become inundated during the 100-year flood event or a Category 1 hurricane, temporarily inhibiting access to the pump station.
Pump Station 5	• Increased Storm Intensity, Duration & Frequency • Excessive Wind Speeds	• Utility power outages causing equipment failure. • Downed trees causing structural or equipment damage.	• Risk of equipment failure from utility power outages is mitigated by the station's stand-by power generator. • A few large trees on the adjacent property do overhang the pump station property and could pose a future blow down risk to the pump station structures.

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
Pump Station 6	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Marsh Migration • Excessive Wind Speeds	• Pump station flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure. • Wetland encroachment on pump station site. • Accessibility issues from flood waters encroaching on access roads.	• The main electrical service, pump controls, VFD panels, and the stand-by generator are all below the 100-year floodplain elevation. A 100-year flood event could pose a significant risk to the pump station's electrical and mechanical equipment. The station is equipped with a 3-ft removable flood barrier for the building entrance and a permanent 2-ft high concrete barrier around the wetwell structure. However, the predicted 100-year flood elevation is above the top of both barriers. A 100-year flood event could pose a significant risk to the pump station's electrical and mechanical equipment. Sea level rise will further increase the station's risk of flooding during large storm events. • Risk of equipment failure from utility power outages is mitigated by the station's stand-by power generator. • Station property abuts wetland area that is part of a larger tidal marsh. However, Maine Geological Survey model data indicate that marsh migration from sea level rise is not likely to be a threat to the station. Refer to Figure PS#6-C in Appendix B-3. • It appears that the pump station's access routes could become inundated during the 100-year flood event or a Category 1 hurricane, temporarily inhibiting access to the pump station.
Pump Station 7	• Increased Storm Intensity, Duration & Frequency • Riverine Flooding • Sea Level Rise • Soil Erosion • Excessive Wind Speeds	• Pump station flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure. • Access road embankment erosion from runoff. • Downed trees causing structural or equipment damage.	• The pump station drywell finish floor and standby generator elevations are above the current 100-year flood elevation, but below the NEIWPCC TR-16 recommended height for critical equipment (3 feet above the 100-year flood elevation). The main electrical service panel is 3+ feet above the 100-year flood elevation. 2+ feet of sea level rise could effectively raise the 100-year flood elevation at the station above the ground-floor finished floor elevation, potentially putting the below-grade pump VFD panels and pump motors at risk of flooding. No historical flood encroachment observed at the pump station by operations staff. • Soil erosion due to excess precipitation and storm intensity is somewhat mitigated by recent drainage improvements on the access roads and a concrete retaining wall installed around the pump station generator. • Risk of equipment failure from utility power outages is mitigated by the station's stand-by power generator. • A few large trees around the pump station property overhang the building structure and the utility power pole adjacent to the station. These trees may pose a future blow down risk during high winds or a hurricane.

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
Pump Station 8	• Increased Storm Intensity, Duration & Frequency • Coastal Flooding • Sea Level Rise • Marsh Migration • Excessive Wind Speeds	• Pump station flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure. • Wetland encroachment on pump station site. • Accessibility issues from flood waters encroaching on access roads. • Downed trees causing structural or equipment damage.	• The main electrical service, pump controls, VFD panels, and the stand-by generator are all below the 100-year floodplain elevation. A 100-year flood event could pose a significant risk to the pump station's electrical and mechanical equipment. The main electrical service panel is slightly above the current 100-year flood elevation, but below the NEIWPCC TR-16 recommended height for critical components (3 feet above the 100-year flood elevation). • Risk of equipment failure from utility power outages is mitigated by the station's stand-by power generator. • Station property abuts wetland area that is part of a larger tidal marsh. However, Maine Geological Survey model data indicate that marsh migration from sea level rise is not likely to be a threat to the station. Refer to Figure PS#8-C in Appendix B-3. • The 2018 FEMA FIRM layer on Figure 8-A in Appendix B-1 shows that the east side Mile Road may become inundated during a 100-year flood event, but the west side of Mile Road should still be able to provide adequate access to the station. • A few large trees around the pump station property overhang the building structure and the stand-by generator fuel tank. These trees may pose a future blow down risk during high winds or a hurricane.
Pump Station 9	• Increased Storm Intensity, Duration & Frequency • Riverine Flooding • Excessive Wind Speeds	• Pump station flooding causing equipment failure and/or damage. • Utility power outages causing equipment failure. • Accessibility issues from flood waters encroaching on access roads. • Downed trees causing structural or equipment damage.	• The pump station entrance and critical mechanical and electrical equipment are 3+ feet above the 100-year flood elevation. The outdoor propane stand-by power generator fuel tank is elevated 6 inches above grade with concrete cinder blocks. • Risk of equipment failure from utility power outages is mitigated by the station's stand-by power engine. • It appears that the pump station's access routes could become inundated during a 100-year flood event, temporarily inhibiting access to the pump station. • A few large trees around the pump station property overhang the stand-by generator fuel tank. These trees may pose a future blow down risk during high winds.
Pump Station 10	• Increased Storm Intensity, Duration & Frequency • Excessive Wind Speeds	• Utility power outages causing equipment failure. • Downed trees causing structural or equipment damage.	• Risk of equipment failure from utility power outages is mitigated by the station's stand-by power engine. • Several large trees on the abutting property may pose a future blow down risk to the pump station structure during high winds.

TABLE 3-5
SEWER COLLECTION SYSTEM VULNERABILITIES

Critical Assets	Potential Vulnerabilities	Potential Consequences	Assessment of Hazard Consequences
Sewer Mains	• Riverine flooding • Flash flooding • Coastal flooding • Sea level rise • Excessive precipitation	• Increased infiltration into pipe cracks and off-set joints from elevated groundwater table. • Pipe embedment undermining from soil erosion. • Increased inflow from sump pumps, roof and perimeter drains connected to the sewer.	• Riverine, coastal, and flash flooding could increase the risk of infiltration into older sections of pipe that are at higher risk of leaks and are located within the floodplain of nearby rivers, streams and brooks, coastal zones and low-lying areas by elevating the local groundwater table and increasing hydrostatic pressure on sewer mains. • Sea level rise could enhance the risk of infiltration into older sections of the sewer system that are at higher risk of leaks and are in coastal flood zones by elevating the local groundwater table and increasing hydrostatic pressure on sewer mains. • Sea level rise could increase the risk of embedment undermining for segments located in coastal flood zones. Staff have not historically observed signs of significant embedment undermining of the gravity sewer mains or force mains.
Manholes	• Riverine flooding • Flash flooding • Coastal flooding • Excessive precipitation	• Increased inflow from flood and precipitation runoff water ponding on top of the manhole structures. • Increased infiltration into manhole seams from elevated groundwater table. • Increase in chloride attack on concrete structures from infiltrating brackish water in flood-prone coastal areas. • SSOs out of manhole structures from elevated wet-weather flows exceeding sewer main capacity.	• Water ponding on top of sewer manholes would be limited to low-lying and slow-draining areas and manholes within coastal flood zones. • Increased infiltration into the sewer manhole seams and cracks would be limited to manholes in poor condition. • Increased chloride attack is possible for leaky manholes near the coastline and brackish water. Staff have not observed significant chloride attack on concrete structures that can be attributed to brackish water infiltration. Chloride exposure would likely be limited to very infrequent flood events and is not considered a significant cause for concern. • The District has not experienced historical SSO problems in the sewer system attributable to excess I/I entering the sewers during wet weather. The WWTF and pumping stations appear to have adequate capacity to accommodate current and future projected flows.

SECTION 4
ADAPTATION MEASURES

4.1 EVALUATION OF ADAPTATION MEASURES

Possible adaptation measures were identified and evaluated based on the findings of the risk assessments. Identified adaptation measures were grouped into two major categories: operational and asset-specific measures. Operational adaptation measures are tasks or procedural changes that District staff could undertake at minimal cost to prevent or mitigate potential hazard consequences. Asset-specific measures include non-routine or one-time tasks, in-depth studies or evaluations, design modifications, or capital expenditures to achieve the goal of preventing or mitigating the potential hazard consequence. Tables 4-1, 4-2, 4-3 and 4-4 summarize potential hazard vulnerabilities and identified adaptation measures for the entire wastewater collection and treatment system, WWTF, pump stations and collection system sewers, respectively.

4.2 PRIORITIZATION OF ADAPTATION MEASURES

The identified system-wide operational adaptation measures listed in Table 4-1 are considered best management practices, and because of their low cost and ease of implementation, were given top priority. Observation-level adaptation measures (e.g., monitoring current conditions and/or trends over time) specific to the WWTF, pump stations and sewer collection system assets in Tables 4-2, 4-3 and 4-4, respectively, were also given top priority. Adaptation measure effectiveness, criticality to system performance and reliability, and estimated cost were considerations in determining the priority of the asset-specific action-level adaptation measures listed in Tables 4-2, 4-3 and 4-4. Table 5-1 in Section 5 of the report summarizes the overall recommended adaptation measure priorities for the WWTF, pump stations and sewer collection system.

TABLE 4-1
SYSTEM-WIDE ADAPTATION MEASURES

Potential Vulnerabilities	Adaptation Measures
Excessive Precipitation & Increased Storm Intensity, Duration & Frequency	• Perform routine inspections of exposed equipment after heavy or intense precipitation events. • Monitor influent flow trends during wet-weather events and snow-melt conditions. • Exercise extreme caution and limit travel time during poor travel conditions. • Perform routine stand-by generator maintenance tasks and schedule routine service inspections with manufacturers/dealers. • Continue to exercise standby generators in accordance with manufacturers recommendations. • Discuss utility power restoration priorities with utility power supply company. • Exercise caution and use proper PPE while working outdoors in wet-weather conditions. • Evaluate I/I reduction in the collection system. • Review written wet-weather management plan to ensure it is up-to-date and make any necessary adjustments. • Review wet-weather management plan with current operations staff and any new hires. • Routinely remove excess snow to facilitate access to critical assets.
Excessive Wind Speeds	• Monitor large trees adjacent to utility power lines and discuss potential risks with utility power supply company. • Perform routine stand-by generator maintenance tasks and schedule routine service inspections with manufacturer/dealer. • Exercise standby generators in accordance with manufacturers recommendations. • Discuss utility power restoration priorities with utility power supply company.

TABLE 4-2
WWTF ADAPTATION MEASURES

Critical Assets	Adaptation Measures
Grit Pump	The grit pump removes grit from the headworks channel and pumps it to the grit washer for further processing. The grit pumps prevent excessive grit build-up in the headworks channel and protect against grit washout into downstream process equipment. The loading dock entrance to the Lower Headworks is at the 100-year FEMA flood elevation of 14 feet. The grit pump is located below this elevation putting it at risk for flooding during a 100-year flood event. Relocating the grit pump is possible but will require significant capital investment for re-piping, a new equipment pad and electrical changes. The existing grit pump could be replaced with a dry-pit submersible type pump that could withstand inundation for short periods. Installing new dry-pit submersible pumps along with ancillary electrical changes to provide grit pump flood protection would be very costly as well. It would be more cost-effective to install a removable temporary flood barrier on the Lower Headworks loading dock doors to reduce the risk of flooding and protect the grit pump to at least the 100-year flood elevation.
Return Activated Sludge (RAS) Pumps	The RAS pumps are critical to proper function of the WWTF's secondary treatment unit process and should be protected against flooding to an elevation three feet above the 100-year floodplain, according to current TR-16 design standards for flood protection of critical process equipment. The existing RAS pumps were upgraded in 2002, and relocating the pumps and control panels to more than three feet above the 100-year flood elevation would require significant changes to the WWTF footprint, making relocation cost prohibitive. Replacing the existing pumps with dry-pit submersible type pumps and relocating the electrical controls equipment is possible but would likely decrease pump efficiency and require significant capital investment. Given the very low risk of flooding to an elevation greater than three feet above the 100-year floodplain, providing removable flood barriers that protect the lower level of the Operations Building from flooding appears to be the most cost-effective solution. Therefore, it is recommended that potential entry points into the Lower Level of the WWTF (such as doors and pipe penetrations) that are less than three feet above the 100-year flood elevation be upgraded with removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building and damaging the RAS pumps.
Waste Activated Sludge (WAS) Pumps	Potential entry points into the Lower Level of the WWTF (such as doors and pipe penetrations) that are less than three feet above the 100-year flood elevation should be upgraded with removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building and damaging the WAS pumps. See RAS pumps discussion above for rationale.

Critical Assets	Adaptation Measures
Dewatering Feed Pumps	The dewatering feed pumps are critical equipment for sludge processing and should be protected against flooding above the 100-year floodplain (TR-16). Relocating the existing feed pumps would require significant re-piping and would be very expensive. Replacing the pumps with new units above the 100-year floodplain would require significant capital investment and would not be cost-effective since the pumps are less than 20 years old. Potential entry points into the Lower Level of the WWTF (such as doors and pipe penetrations) that are less than two feet above the 100-year flood elevation should be upgraded with removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building and damaging the dewatering feed pumps. See RAS pumps discussion above for rationale.
Dewatering Centrifuges	The dewatering centrifuges are in the Dewatering Room on the Upper Floor of the Operations Building, three feet above the 100-year flood elevation (14 ft). Therefore, the risk of flooding in the Dewatering Room would be very unlikely. However, sea level rise could increase the risk of flood damage by effectively raising the 100-year flood elevation. Sea level rise and flooding at the WWTF should be monitored and a long-term record developed to identify any upward trends in sea level locally.
Aeration System Blowers	Relocating or replacing the existing aeration system blowers would require significant re-piping and capital investment. Therefore, potential entry points into the Lower Level of the WWTF (such as doors and pipe penetrations) that are less than three feet above the 100-year flood elevation should be upgraded with removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building and damaging the blowers.
Effluent Pumps	The plant effluent pumps are critical to proper function of the WWTF's secondary treatment unit process and should be protected against flooding to an elevation three feet above the 100-year floodplain, according to current TR-16 design standards for flood protection of critical equipment. Relocating or replacing the existing effluent pumps would require significant re-piping and capital investment. Replacing the existing pumps with dry-pit submersible type pumps and relocating the electrical controls equipment is possible but would also require significant capital investment. Therefore, potential entry points into the Lower Level of the WWTF (such as doors and pipe penetrations) that are less than three feet above the 100-year flood elevation should be upgraded with removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building and damaging the effluent pumps.
Plant Water System	A skid-mounted package plant water system could be purchased and located above the 100-year floodplain. However, this would be very expensive and require significant process piping changes. The current plant water system is less than 20 years old, therefore, it is more cost-effective to leave the existing plant water system in place and provide removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building. The cost of replacing the plant water system at a new location above the 100-year floodplain should be reassessed once it has reached the end of its remaining useful life.
Scum Pumps	Potential entry points into the Lower Level of the WWTF (such as doors and pipe penetrations) that are less than three feet above the 100-year flood elevation should be upgraded with removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building and damaging the scum pumps. See RAS pumps discussion above for rationale.
Flow Meter	The plant flow meter is important for process control and Waste Discharge License monitoring and should be protected against flooding up to two feet above the 100-year floodplain, according to current TR-16 design standards for flood protection of non-critical equipment. Given the interruption to process control and re-piping required to relocate the existing flow meter to a new location above the 100-year floodplain, it is more cost-effective to upgrade potential entry points into the Lower Level of the WWTF (such as doors and pipe penetrations) that are less than two feet above the 100-year flood elevation with removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building and damaging the flow meter.

Critical Assets	Adaptation Measures
Chlorine Contact Chamber	Replacing the existing chlorine contact chamber with a new chlorine contact tank above the 100-year floodplain elevation to reduce flooding risk alone would be cost-prohibitive. When the chlorine contact chamber has reached the end of its useful life, the cost to install a new structure more than three feet above the 100-year floodplain should be reviewed. It is recommended that any potential entry points into the Lower Level of the WWTF be protected to three feet above the 100-year flood elevation with removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building and the chlorine contact chamber.
Sludge Conditioning Mixer	The sludge conditioning mixer cannot be relocated above the 100-year floodplain without also relocating the sludge conditioning tank. Replacing both the mixer and the conditioning tank would be less cost-effective than installing removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building where the mixer and conditioning tank are located. It is recommended that removable temporary barriers be installed to prevent flood waters to an elevation two feet above the 100-year floodplain from entering the Lower Level of Operations Building and damaging the sludge conditioning mixer.
Chemical Feed Pumps	The chemical feed pumps are critical to process control and maintaining Waste Discharge License compliance and should be protected against flooding to an elevation three feet above the 100-year floodplain, according to current TR-16 design standards for flood protection of critical equipment. Relocating the chemical feed pumps is possible, but would be expensive and require installing additional chemical feed piping. It would be more cost-effective to install removable temporary barriers to prevent flood waters to an elevation three feet above the 100-year floodplain from entering the Lower Level of the Operations Building to protect the chemical feed pumps.
HVAC System	The WWTF heating system is critical to prevent freezing problems in the winter that could negatively affect process equipment and piping. Relocating the boiler and re-piping portions of the heating system would be expensive and not cost-effective if the District is already considering installing removable temporary barriers to protect other critical process equipment in the Lower Level of the Operations Building.
WWTF Electrical Support Systems	Some of the electrical support systems for critical process equipment (electrical control panels, local disconnect switches, electrical conduit, etc.) is located in the Lower Level of the Operations Building below grade and below the existing 100-year flood elevation. If the Lower Level flooded, these electrical controls could fail and could become permanently damaged. Some electrical systems could be relocated in the Upper Level of the Operations Building, with sealed conduit running to the equipment in the Lower Level. However, this would be expensive and would not be feasible for all critical equipment located in the Operations Building Lower Level. It would be more cost effective to install removable temporary barriers to prevent flood waters from entering the Lower Level of Operations Building to protect the electrical support systems.

TABLE 4-3
PUMP STATION ADAPTATION MEASURES

Critical Assets	Adaptation Measures
Pump Station 1	• Upgrading the pump station's electrical equipment to relocate it more than three feet above the 100-year floodplain would be expensive and would require a new expanded upper level of the pump station structure. If the station were substantially upgraded, this would necessitate compliance with current fire codes, including either new explosion-proof electrical equipment or continuous mechanical ventilation of the lower levels of the pump station. Continuous mechanical ventilation would also require heating of the incoming air during the winter months and cooling during the summer months to maintain acceptable atmospheric conditions in the pump station. It would be more cost-effective to upgrade the temporary barriers around the pump station entrance to withstand flooding to an elevation three feet above the 100-year flood elevation than to relocate the pump station's electrical systems three feet above the 100-year floodplain elevation. • The existing emergency generator is nearly 40 years old and is reaching the end of its useful life. It should be upgraded within the next five years to maintain pump station operations during an extended utility power failure. When the generator is replaced, the District should assess relocating the intake louver to the pump station building roof and raising exhaust louver to three feet above the 100-year floodplain, or as high as feasibly possible, for added flood protection. • The District should work with the property owners of the adjacent lot to monitor the trees located near the pump station building for signs of disease or rot that would increase the risk of blow down on the pump station structure. • The District should monitor marsh migration onto the pump station property over time. If marsh migration becomes significant over time, the District evaluate constructing an earthen berm around the station structure to prevent further encroachment. • The District should consider purchasing a small flat bottom boat for deployment if flood waters restrict vehicle access to the pump station site. • The District should consider developing an emergency pump station access plan and procedures manual with operations staff in case flooding restricts typical access routes to pump station. • It is recommended that the District add Pump Station 1 to the local power utility's priority list for utility power restoration after a natural disaster.
Pump Station 2	• Upgrading the pump station's electrical equipment to relocate it more than three feet above the 100-year floodplain would be expensive and would require a new expanded upper level of the pump station structure. If the station were substantially upgraded, this would necessitate compliance with current fire codes, including either new explosion-proof electrical equipment or continuous mechanical ventilation of the lower levels of the pump station. Continuous mechanical ventilation would also require heating of the incoming air during the winter months and cooling during the summer months to maintain acceptable atmospheric conditions in the pump station. It would be more cost-effective to upgrade the temporary barriers around the pump station entrance to withstand flooding to an elevation three feet above the 100-year flood elevation than to relocate the pump station's electrical systems three feet above the 100-year floodplain elevation. • The existing emergency generator is nearly 40 years old and is reaching the end of its useful life. It should be upgraded within the next five years to maintain pump station operations during an extended utility power failure. When the generator is replaced, the intake louver should be located on the pump station building roof to protect against flooding and the exhaust louver should be raised to three feet above the 100-year floodplain or as high as feasibly possible. • The District should monitor marsh migration onto the pump station property over time. If marsh migration becomes significant over time, the District evaluate constructing an earthen berm around the station structure to prevent further encroachment. • The District should consider purchasing a small flat bottom boat for deployment if flood waters restrict vehicle access to the pump station site. • The District should consider developing an emergency pump station access plan and procedures manual with operations staff in case flooding restricts typical access routes to pump station. • It is recommended that the District add Pump Station 2 to the local power utility's priority list for utility power restoration after a natural disaster.

Critical Assets	Adaptation Measures
Pump Station 3	• Relocating the electrical controls to more than three feet above the 100-year floodplain would be expensive and would require a new expanded upper level of the pump station structure to accommodate the VFD panels and additional controls equipment. A substantial upgrade to the pump station structure would necessitate compliance with current fire codes, including either new explosion-proof electrical equipment or continuous mechanical ventilation of the lower levels of the pump station. Continuous mechanical ventilation would also require heating incoming air during the winter and cooling during the summer to maintain acceptable working conditions. It would be more cost-effective install new temporary barriers around the pump station entrance to withstand flooding to an elevation three feet above the 100-year flood elevation than to relocate the pump station's electrical systems three feet above the 100-year floodplain elevation. • The existing emergency generator is nearly 40 years old and is reaching the end of its useful life. It should be evaluated for replacement within the next five to ten years to maintain pump station operations during an extended utility power failure. • Sea level rise and flooding should be monitored and a long-term record developed to identify any upward trends in sea level locally. • The District should consider developing an emergency pump station access plan and procedures manual with operations staff in case flooding restricts typical access routes to pump station.
Pump Station 4	• Relocating the electrical controls to more than three feet above the 100-year floodplain would be expensive and would require a new expanded upper level of the pump station structure to accommodate the VFD panels and additional controls equipment. A substantial upgrade to the pump station structure would necessitate compliance with current fire codes, including either new explosion-proof electrical equipment or continuous mechanical ventilation of the lower levels of the pump station. Continuous mechanical ventilation would also require heating incoming air during the winter and cooling during the summer to maintain acceptable working conditions. It would be more cost-effective install new temporary barriers around the pump station entrance to withstand flooding to an elevation three feet above the 100-year flood elevation than to relocate the pump station's electrical systems three feet above the 100-year floodplain elevation. • The District should monitor marsh migration onto the pump station property over time. If marsh migration becomes significant over time, the District evaluate constructing an earthen berm around the station structure to prevent further encroachment. • The District should consider developing an emergency pump station access plan and procedures manual with operations staff in case flooding restricts typical access routes to pump station.
Pump Station 5	• The District should work with the property owners of the adjacent lot to monitor the trees located near the pump station building for signs of disease or rot that would increase the risk of blow down on the pump station structure. • The existing emergency generator should be evaluated for replacement within the next ten to fifteen years to maintain pump station operations during an extended utility power failure.
Pump Station 6	• Relocating the electrical controls to more than three feet above the 100-year floodplain would be expensive and would require a new expanded upper level of the pump station structure to accommodate the VFD panels and additional controls equipment. A substantial upgrade to the pump station structure would necessitate compliance with current fire codes, including either new explosion-proof electrical equipment or continuous mechanical ventilation of the lower levels of the pump station. Continuous mechanical ventilation would also require heating incoming air during the winter and cooling during the summer to maintain acceptable working conditions. It would be more cost-effective install new temporary barriers around the pump station entrance to withstand flooding to an elevation three feet above the 100-year flood elevation than to relocate the pump station's electrical systems three feet above the 100-year floodplain elevation. • The existing emergency generator is nearly 40 years old and is reaching the end of its useful life. It should be evaluated for replacement within the next five years to maintain pump station operations during an extended utility power failure. • The District should monitor marsh migration onto the pump station property over time. If marsh migration becomes significant over time, the District evaluate constructing an earthen berm around the station structure to prevent further encroachment. • The District should consider developing an emergency pump station access plan and procedures manual with operations staff in case flooding restricts typical access routes to pump station.

Critical Assets	Adaptation Measures
Pump Station 7	• Sea level rise and flooding should be monitored and a long-term record developed to identify any upward trends in sea level locally. • The District should work with the property owners of the adjacent lot to monitor the trees located near the pump station building for signs of disease or rot that would increase the risk of blow down on the pump station structure.
Pump Station 8	• Relocating the electrical controls to more than three feet above the 100-year floodplain would be expensive and would require a new expanded upper level of the pump station structure to accommodate the VFD panels and additional controls equipment. A substantial upgrade to the pump station structure would necessitate compliance with current fire codes, including either new explosion-proof electrical equipment or continuous mechanical ventilation of the lower levels of the pump station. Continuous mechanical ventilation would also require heating incoming air during the winter and cooling during the summer to maintain acceptable working conditions. It would be more cost-effective install new temporary barriers around the pump station entrance to withstand flooding to an elevation three feet above the 100-year flood elevation than to relocate the pump station's electrical systems three feet above the 100-year floodplain elevation. • The existing emergency generator is nearly 40 years old and is reaching the end of its useful life. It should be evaluated for replacement within the next five years to maintain pump station operations during an extended utility power failure. • The District should consider developing an emergency pump station access plan and procedures manual with operations staff in case flooding restricts typical access routes to pump station. • The District should work with the property owners of the adjacent lot to monitor the trees located near the pump station building for signs of disease or rot that would increase the risk of blow down on the pump station structure.
Pump Station 9	• The District should consider mounting the propane fuel tank on a permanent concrete equipment pad to decrease the risk of a possible propane leak if the cinder block footings fail in the future. • The District should consider developing an emergency pump station access plan and procedures manual with operations staff in case flooding restricts typical access routes to pump station. • The District should work with the property owners of the adjacent lot to monitor the trees located near the pump station building for signs of disease or rot that would increase the risk of blow down on the pump station structure.
Pump Station 10	• The District should consider mounting the propane fuel tanks on a permanent concrete equipment pad to decrease the risk of a possible propane leak if the cinder block footings fail in the future. • The District should work with the property owners of the adjacent lot to monitor the trees located near the pump station building for signs of disease or rot that would increase the risk of blow down on the pump station structure.

TABLE 4-4
SEWER COLLECTION SYSTEM ADAPTATION MEASURES

Critical Assets	Adaptation Measures
Sewer System (gravity mains, pressure pipes, and manhole structures)	• Evaluate drainage improvements in areas with significant local flooding or ponding of water on sewer manholes. • Complete a house-to-house private inflow sources survey and enforce illicit sewer connection ordinance to reduce I/I. • Frequent cleaning and CCTV inspection of areas suspected of higher I/I and grit build-up. • Evaluate identified higher I/I areas for sewer system relining upgrades. • Monitor cross-country sewer lines for signs of ponding on manholes and embedment erosion. • Evaluate and install water-tight manhole covers in low-lying and flood-prone areas, as needed.

SECTION 5
RECOMMENDED ADAPTATION PLAN

5.1 IMPLEMENTATION PLAN

The identified operational and system-wide adaptation measures are recommended as a top priority because of their low cost and ease of implementation. Asset-specific adaptation measures were prioritized considering measure effectiveness, criticality to system performance and reliability, and estimated cost. A summary of the recommended adaptation measures, timeline for implementation and planning-level project costs were prepared and are presented in Table 5-1 at the end of this section. The planning-level costs were developed using standard cost estimating procedures consistent with industry standards. The project cost information presented herein is in current dollars and is based on Engineering News Record (ENR) Index 11380 (November, 2019). These estimates have been developed primarily for evaluating alternative solutions and are generally reliable for determining the relative costs of various options. Many factors arise during final design (e.g. owner selected features and amenities, code issues, etc.) that cannot be definitively identified and estimated at this time.

5.2 POTENTIAL FUNDING SOURCES

5.2.1 Internal Reserves

The District has internal budget reserves for minor capital improvements and expenditures that could be used to fund limited climate adaptation measures. Reserve funds could be used for relatively low-cost operational or process modifications and/or minor capital improvement projects. This would be the preferred funding mechanism for the recommended CAP measures since using existing budget reserve funds does not require raising sewer user rates to cover the cost.

5.2.2 Local Revenue

For adaptation measures that cannot be covered by budget reserves alone, the District could raise the revenues needed to cover costs by implementing a structured sewer user rate increase.

Generated revenues could be used for low-cost operational or process modifications, and both minor and significant capital improvements. This would be a less desirable funding mechanism than using budgeted reserves because it would require increasing sewer user rates.

5.2.3 State Funding

Some adaptation measures requiring capital improvements may be eligible for financial assistance from the State of Maine through the Community Development Block Grant (CDBG) program or the CWSRF loan program.

The Maine Department of Economic and Community Development administers the CDBG program for the State of Maine. Grants are provided to municipalities and quasi-municipal entities for eligible capital improvement projects. The District could work with the Town of Wells to apply for CDBG funds to implement recommended CAP specialized adaptation measures with a significant capital cost. CDBG funding would be preferable to CWSRF loan funding because grant funds would not need to be repaid. To be eligible for CDBG funds, the District would need to work with the Town of Wells to complete a grant application and other CDBG program requirements including an environmental review report and a preliminary engineering report. The District would be competing in a state-wide pool of applicants for limited grant funds. The next round of applications for CDBG funding is the first quarter of 2020.

The Maine DEP CWSRF program provides low-interest loans to local communities and quasi-municipal entities for wastewater infrastructure improvement projects. CAP specialized adaptation measures with a significant capital cost are likely be eligible for CWSRF loan funding. CWSRF loan principal and interest would need to be fully repaid over the term of the loan (typically 20 years or the expected life of the asset) unless the District qualified for partial principal forgiveness. To be eligible for a CWSRF loan, the District would need to complete a CWSRF loan application with the Maine Municipal Bond Bank and other CWSRF program requirements including an environmental impact review report and preliminary design report.

5.2.4 Federal Funding

The U.S. Department of Agriculture (USDA) Rural Development (RD) offers Water & Waste Disposal Predevelopment Grants to eligible communities to assist with the initial planning and development of RD Water & Waste Disposal direct loans/grants. RD also offers Water & Waste Disposal direct loans/grants for sanitary sewage disposal, solid waste disposal and storm water drainage projects. The District would likely qualify for RD water & waste disposal loan funding only given the income eligibility requirement to qualify for RD grant funding.

For CDBG, CWSRF and RD funding, applicants are required to prepare an environmental review report and preliminary engineering report. The State of Maine's CDBG and CWSRF programs are willing to accept an environmental impact review report and preliminary engineering report prepared for RD funding to satisfy their requirements. Therefore, if the Town intends to seek outside funding for the recommended CAP specialized adaptation measures, it is recommended that an environmental impact review report and preliminary engineering report be prepared to RD standards to satisfy the preliminary requirements of all three funding programs.

FEMA Flood Mitigation Assistance (FMA) grants are available for planning and construction projects that reduce or eliminate long-term risk of flood damage to structures insured under the National Flood Insurance Program (NFIP). The District would be required to submit a project application to the State Hazard Mitigation Officer to then be forwarded on to the Regional FEMA office for review and approval. The hazard mitigation project would also be required to conform with the State and local Hazard Mitigation Plans to be eligible for FMA grants. The District would be competing for FMA grant funds within a national pool of applicants. Grant funding is a preferable method to implement CAP adaptation measures and could a possible funding source for some adaptation measures that reduce or eliminate long-term risk of flood damage.

The Water Infrastructure Finance and Innovation Act of 2014 (WIFIA) established the WIFIA program, a federal credit program administered by EPA for eligible water and wastewater infrastructure projects. Eligible borrowers include local, state, tribal, and federal government entities, partnerships and joint ventures, corporations and trusts and Clean Water and Drinking Water State Revolving Fund (SRF) programs.

The WIFIA program can fund projects that are eligible for CWSRF funding including development phase activities such as planning, preliminary engineering, design, environmental review, revenue forecasting, and other pre-construction activities, construction, reconstruction, rehabilitation, and replacement work, acquisition of real property or an interest in real property, environmental mitigation, construction contingencies, and acquisition of equipment.

Although design and construction costs of the recommended adaptation measures in Table 5-1 would be categorically eligible for federal WIFIA program funds, the WIFIA program can only fund up to 49% of project costs and requires a minimum project size of $5 million. In addition, typical CWSRF program requirements including an Environmental Review, Davis-Bacon wage rates and American Iron and Steel requirements would apply to WIFIA funding. Given these eligibility criteria and funding limitations, WIFIA program financing would not be a preferred funding source when compared to USDA Rural Development, CDBG and the Maine DEP CWSRF funding programs.

TABLE 5-1
CAP IMPLEMENTATION PLAN & ESTIMATED COSTS

1—Highest Priority | 2—High Priority | 3—Moderate Priority | 4—Lower Priority

Priority	Critical Asset	Adaptation Measures	Timeline for Implementation	Estimated Capital Cost*
1	System-wide	Implement at-risk asset monitoring and all operational adaptation measures identified in the CAP report.	0-5 years	<$1,000
1	WWTF Critical and Non-Critical Process and HVAC Equipment and Electrical Support Systems in Lower Level of Operations Building	Install removable flood barriers to protect the Operations Building up to 3 feet above the 100-year floodplain elevation and confirm conduit and pipe penetrations less than 3 feet above the 100-year floodplain elevation are watertight.	0-5 years	$125,000
1	Grit Pumps	Install removable flood barriers to protect the Lower Headworks up to 3 feet above the 100-year floodplain elevation and raise main power feeder junction box from the Operations Building three feet above the 100-year floodplain.	0-5 years	$50,000
1	WWTF Electrical Support Systems	Evaluate raising the main power feed transformer on the WWTF site to 3 feet above the 100-year floodplain.	0-5 years	$5,000**
1	WWTF Critical and Non-Critical Process Equipment and Electrical Support Systems	Request that the WWTF be added to local power utility's priority list for power restoration after a natural disaster or widespread utility power outage.	0-5 years	$0
1	Pump Stations 1, 2, 3, 4, 6 & 8	Install removable flood barriers to protect the station up to 3 feet above the 100-year floodplain elevation.	0-5 years	$50,000-$75,000/station
1	Pump Stations 1 & 2	Replace the existing stand-by power generator and transfer switch, electrical upgrades and evaluation of HVAC modifications to provide further flood protection.	0-5 years	$250,000/station
1	Pump Stations 1, 2, 3, 4, 6 & 8	Purchase flat-bottom boat to provide emergency access to pump stations during extreme flood conditions.	0-5 years	$30,000
1	Pump Stations 1, 2, 3, 4, 6, 8 & 9	Develop emergency pump stations access plan and procedures manual with operations staff in case flooding restricts typical access routes to pump station.	0-5 years	$15,000-$20,000 (all stations)
1	Pump Stations 1 & 2	Request that these pump stations be added to local power utility's priority list for power restoration after a natural disaster or widespread utility power outage.	0-5 years	$0

Priority	Critical Asset	Adaptation Measures	Timeline for Implementation	Estimated Capital Cost*
2	Pump Stations 3, 5, 6, 8	Replace existing emergency stand-by power generator, transfer switch and electrical upgrades.	5-10 years	$200,000/station
3	Pump Stations 9 & 10	Mount propane fuel tank on permanent concrete equipment pad.	10-15 years	$5,000/station
3	Sewer System	Evaluate drainage improvements in areas with significant local flooding or ponding of water on sewer manholes.	10-15 years	$20,000-$30,000**
4	Pump Stations 1, 5, 7, 8, 9 & 10	Remove trees showing signs of rot or disease that could pose a blow-down risk onto the station.	As needed	$5,000-$10,000*/station
4	Pump Stations 1, 2, & 6	Evaluate installing constructed earthen berm to slow significant marsh migration.	As needed	$5,000**
4	Sewer System	Complete a house-to-house private inflow sources survey and enforce illicit sewer connection ordinance to reduce I/I.	15-20 years	$20,000-$50,000
4	Sewer System	Perform frequent cleaning and CCTV inspection of areas suspected of higher I/I and grit build-up.	As needed	$3.00-$5.00/LF
4	Sewer System	Evaluate identified higher I/I areas for sewer system relining upgrades.	As needed	$10,000-$20,000**
4	Sewer System	Install water-tight manhole covers in low-lying and flood-prone areas.	As needed	$1,000-$2,000/manhole

*Final project cost will depend on scope of work, the extent of which is beyond the scope of this report.
**Cost estimate is for evaluation only. Cost for subsequent capital improvements not included.

Appendix A

GIS Maps

A-1: Major Pumping Stations Service Areas Map

Pump Station Sewersheds

Climate Adaptability

Wells, ME

PROJ NO: 14187 DATE: 8/14/2019 FIGURE: 5

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A-2: WPCF & Sewer System Map

Preliminary FIRM 2018

Climate Adaptability

Wells, ME

PROJ NO: 14187	DATE: 8/14/2019	FIGURE: 6

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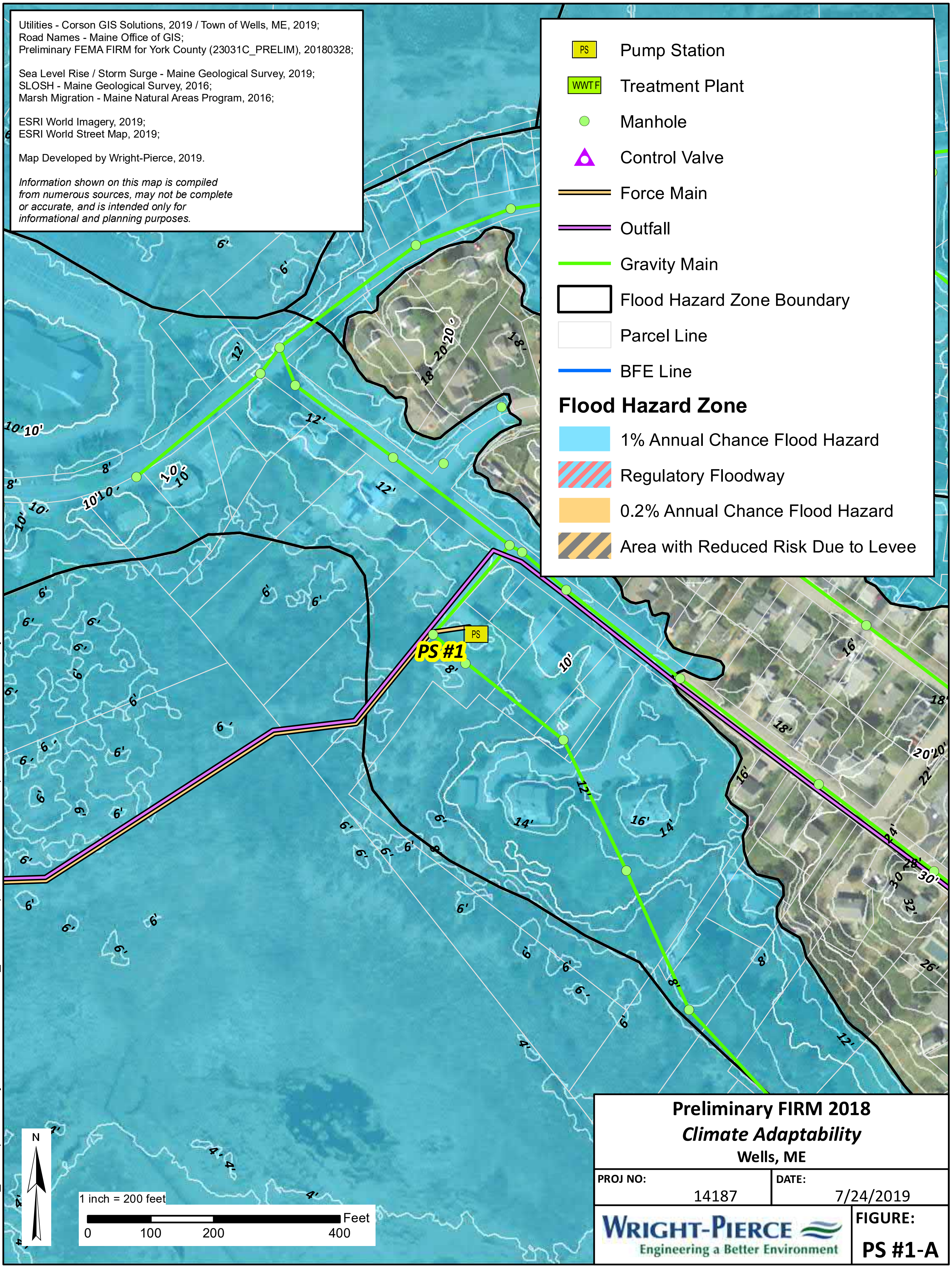
Appendix B

Major Pumping Stations & WPCF Map Book

B-1: FEMA Preliminary FIRM Maps



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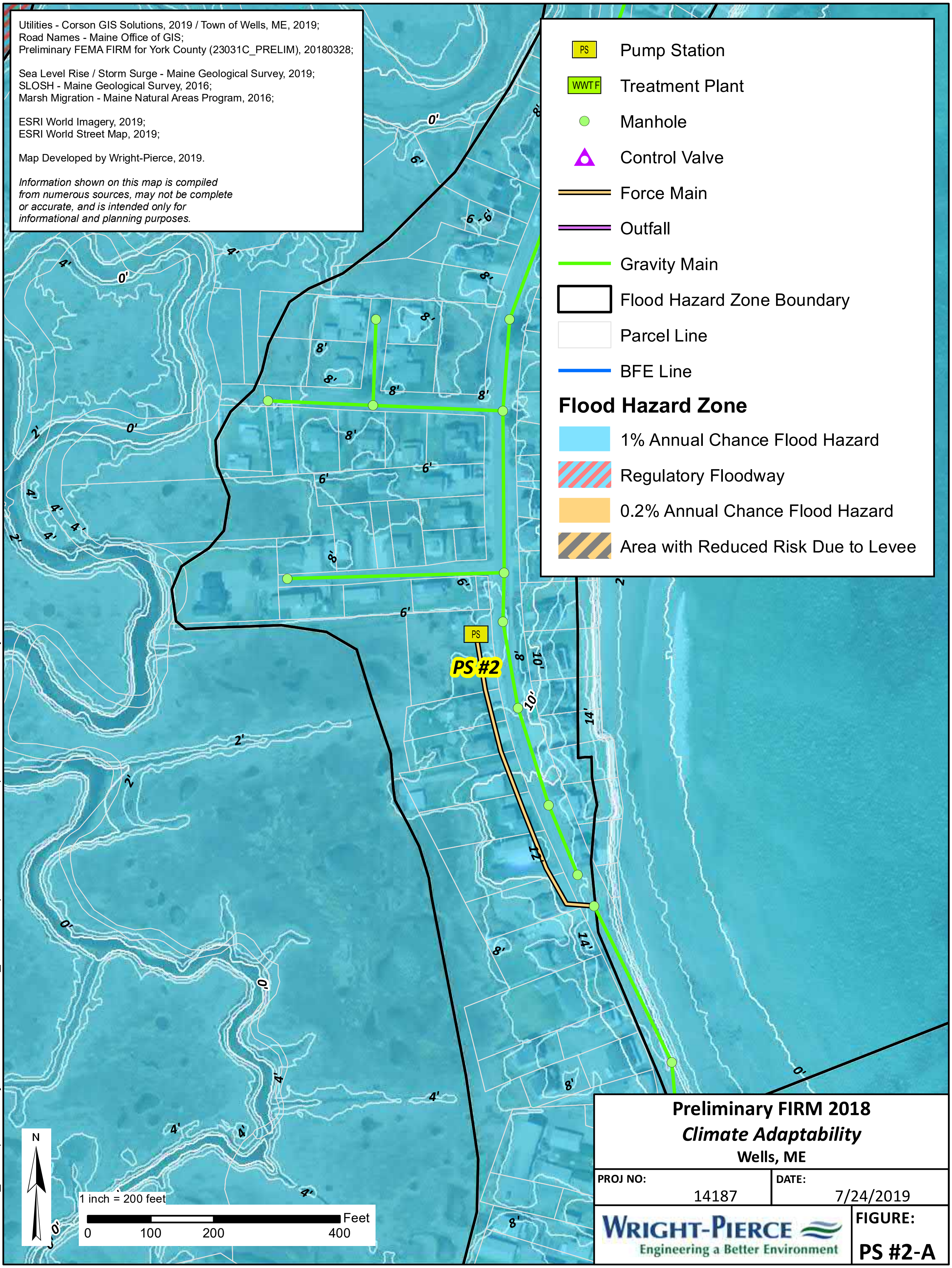
Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
Preliminary FEMA FIRM for York County (23031C_PRELIM), 20180328;

Sea Level Rise / Storm Surge - Maine Geological Survey, 2019;
SLOSH - Maine Geological Survey, 2016;
Marsh Migration - Maine Natural Areas Program, 2016;

ESRI World Imagery, 2019;
ESRI World Street Map, 2019;

Map Developed by Wright-Pierce, 2019.

Information shown on this map is compiled from numerous sources, may not be complete or accurate, and is intended only for informational and planning purposes.



Preliminary FIRM 2018
Climate Adaptability
Wells, ME

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14187	7/24/2019

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FIGURE:
PS #2-A

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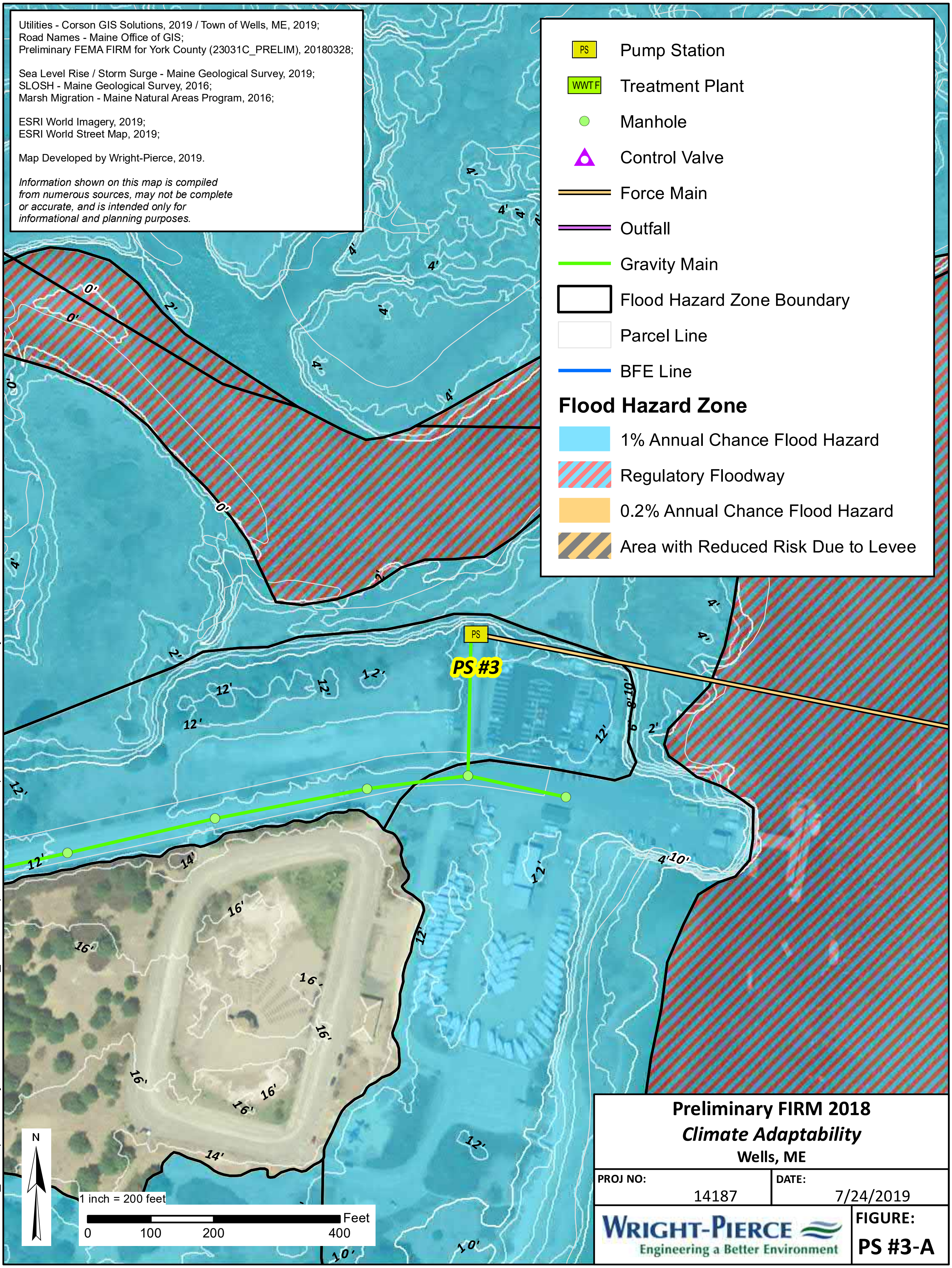

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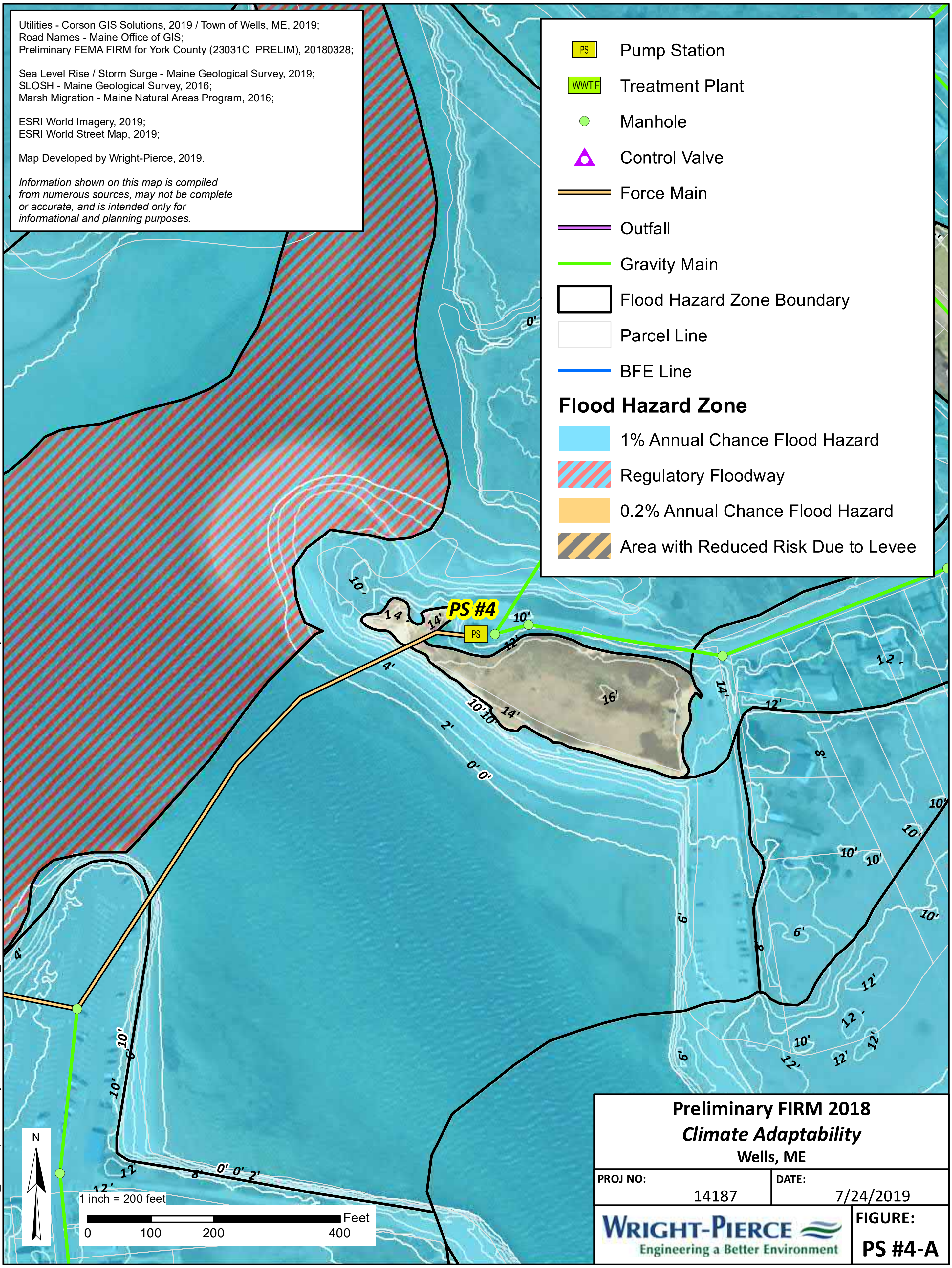

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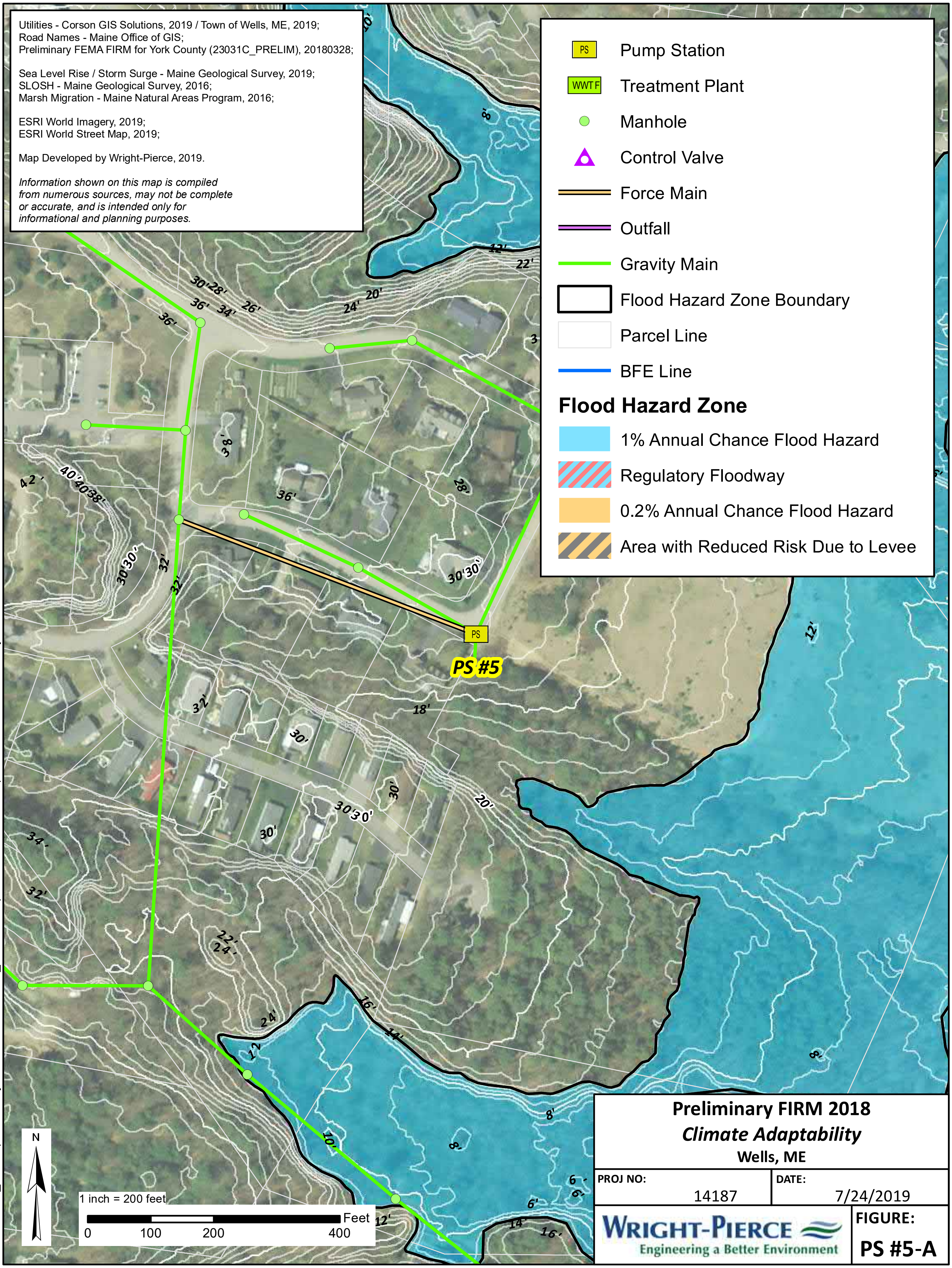

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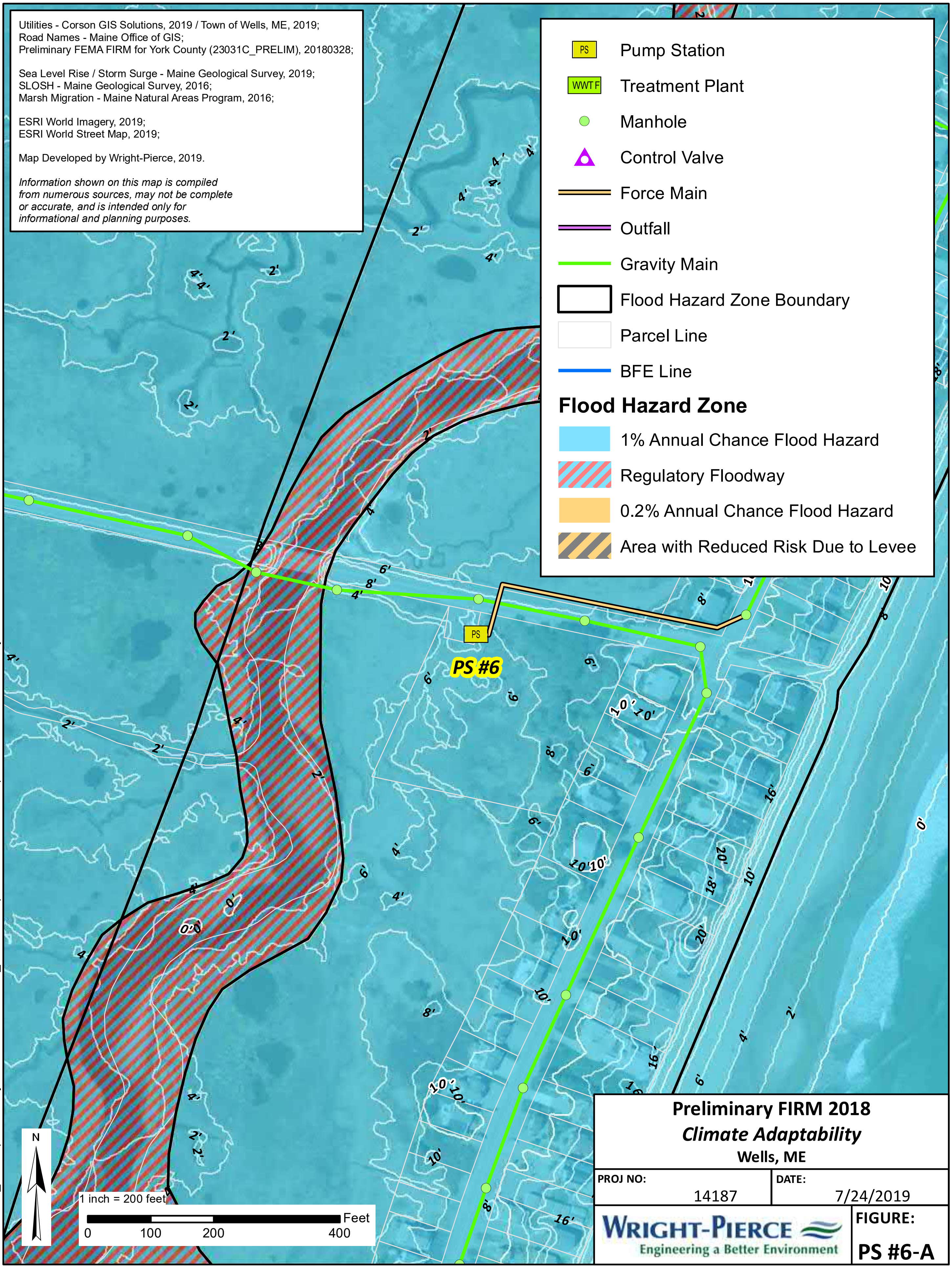

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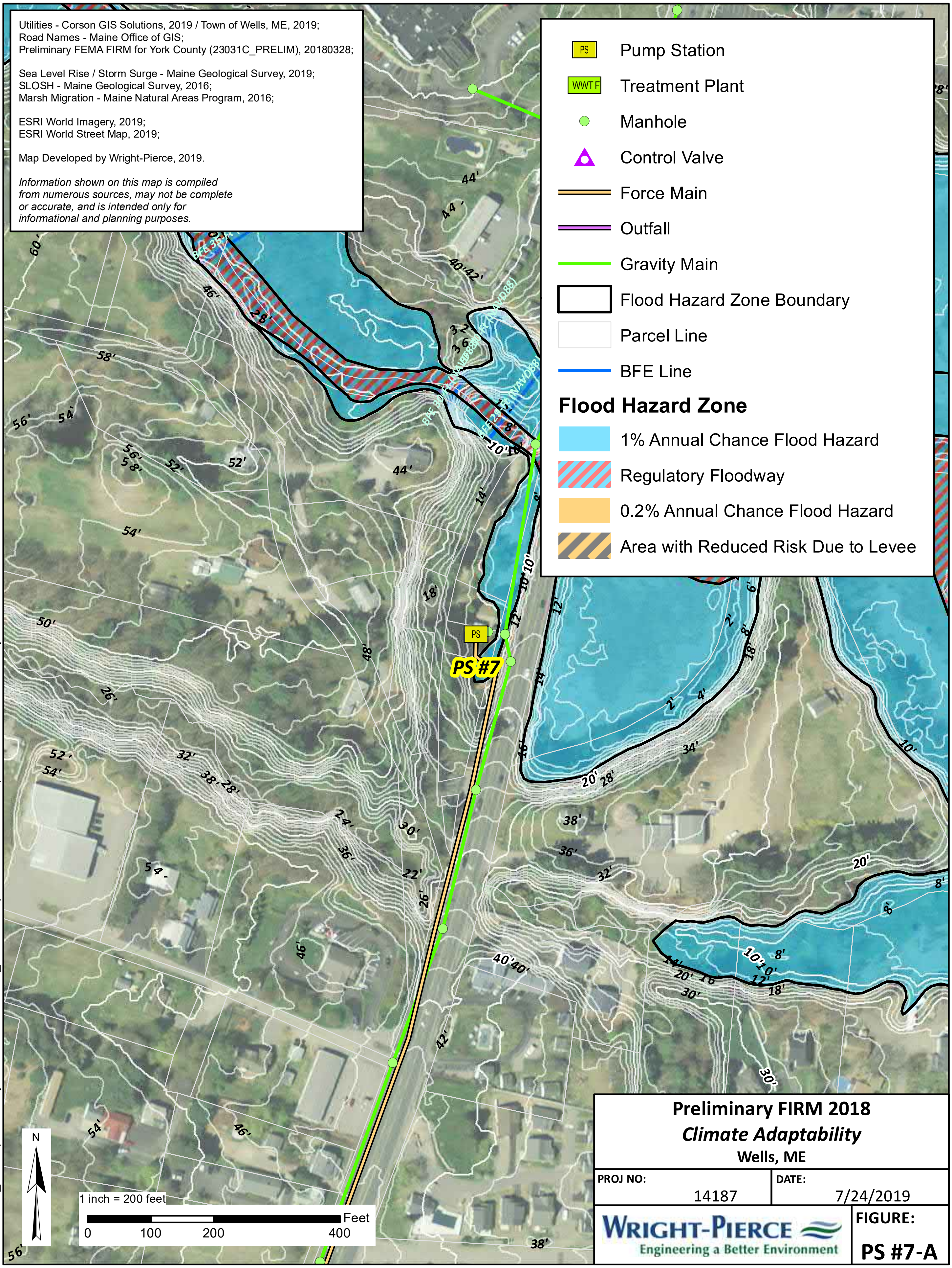

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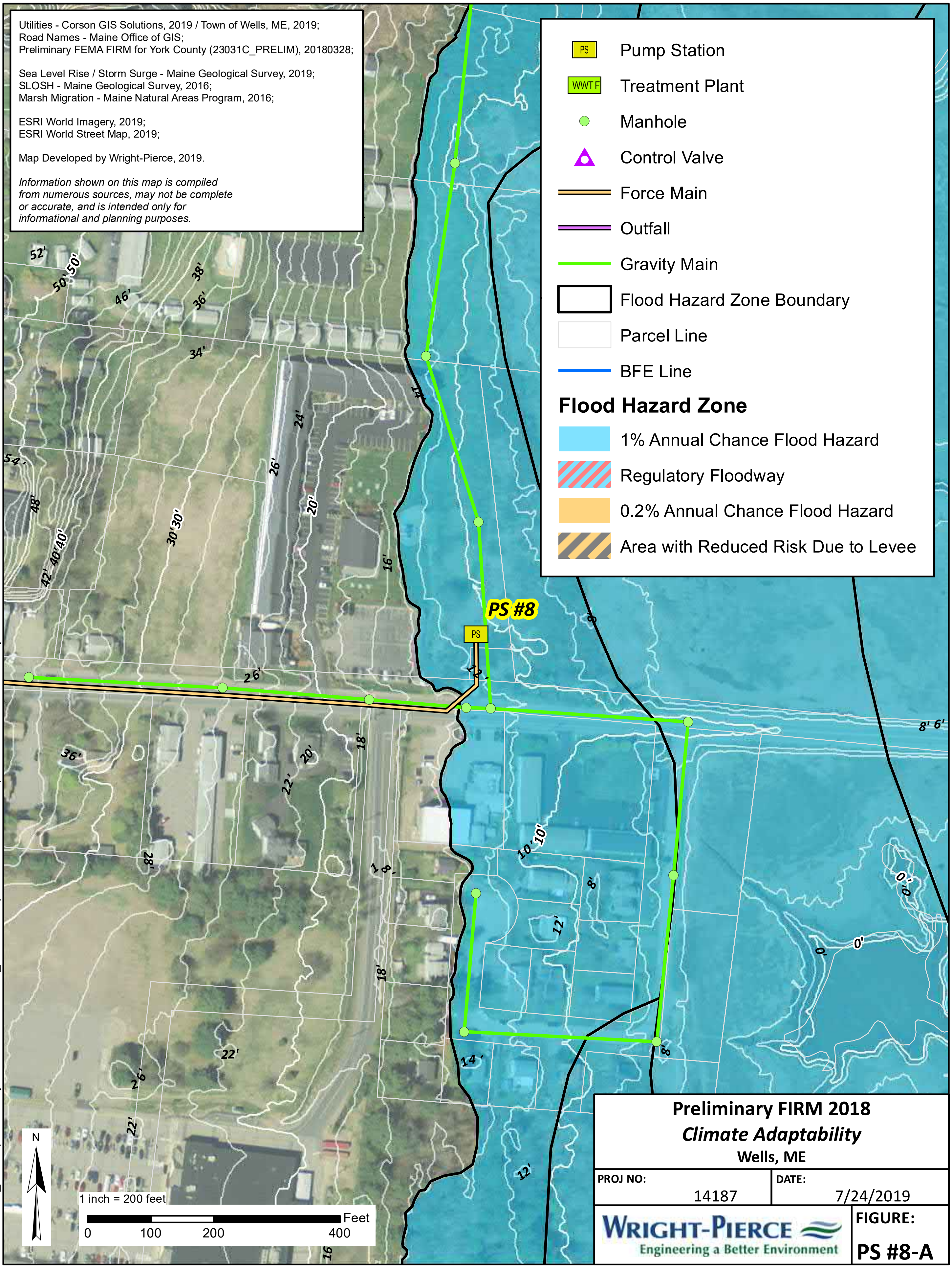

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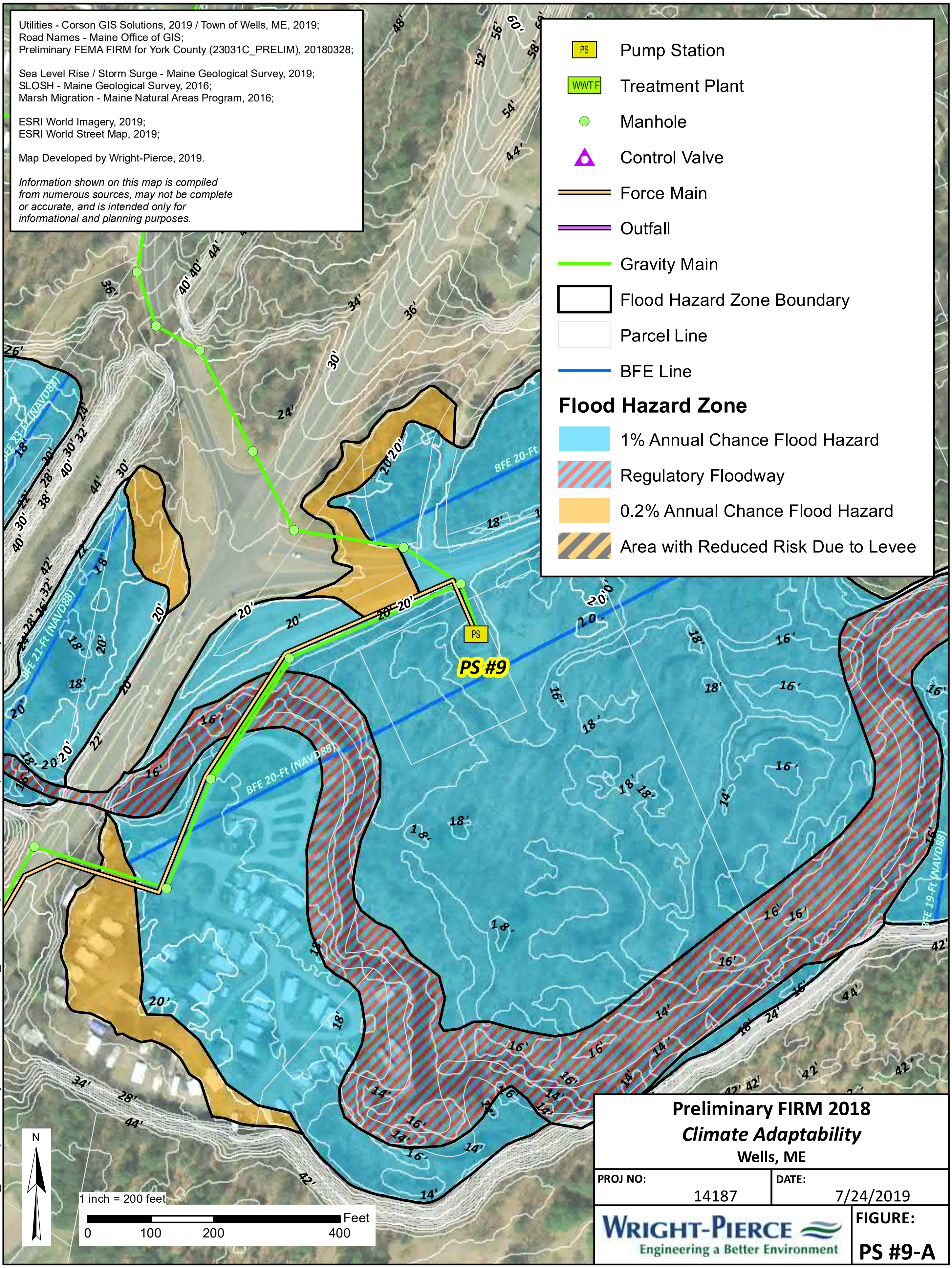

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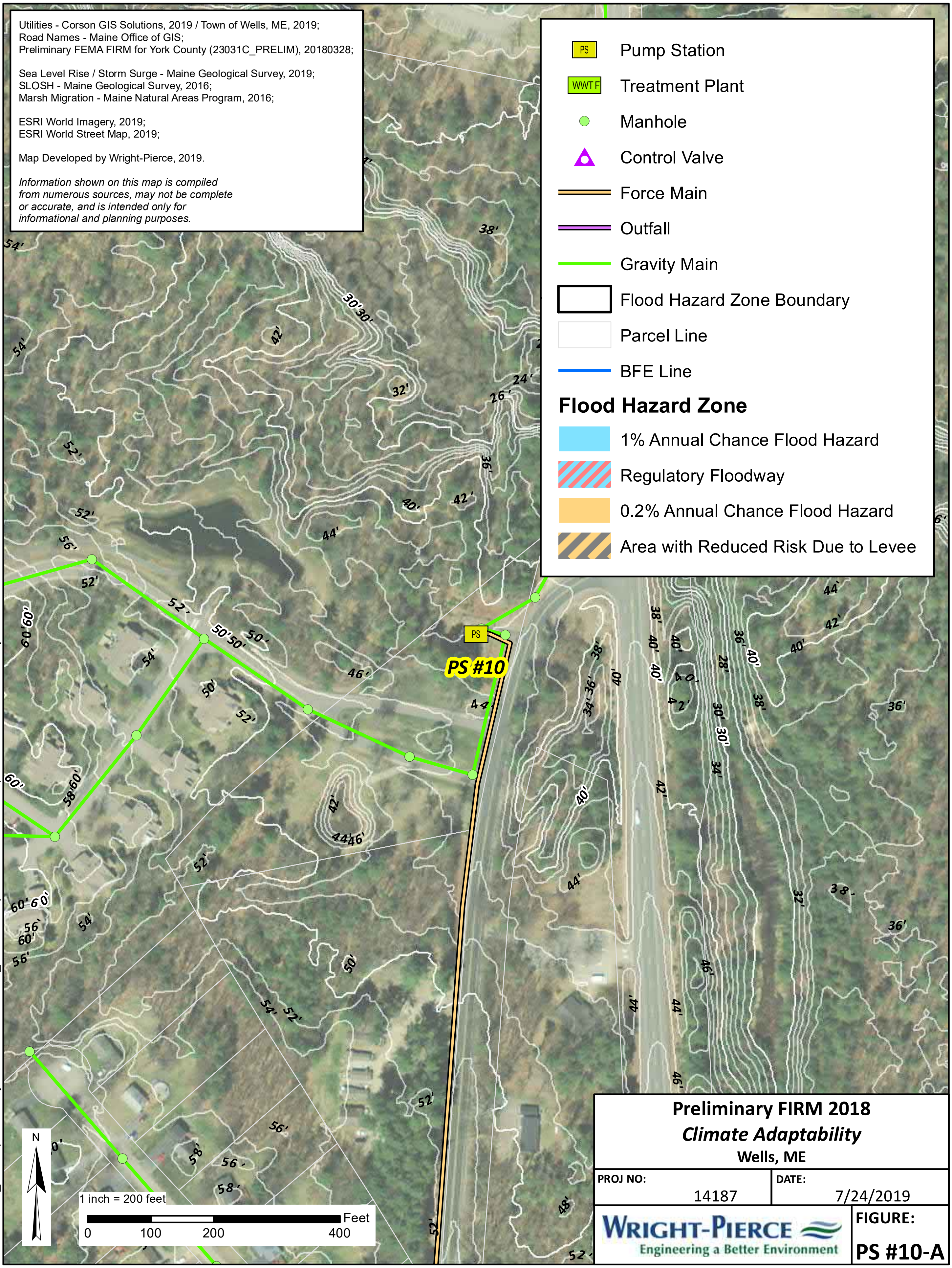

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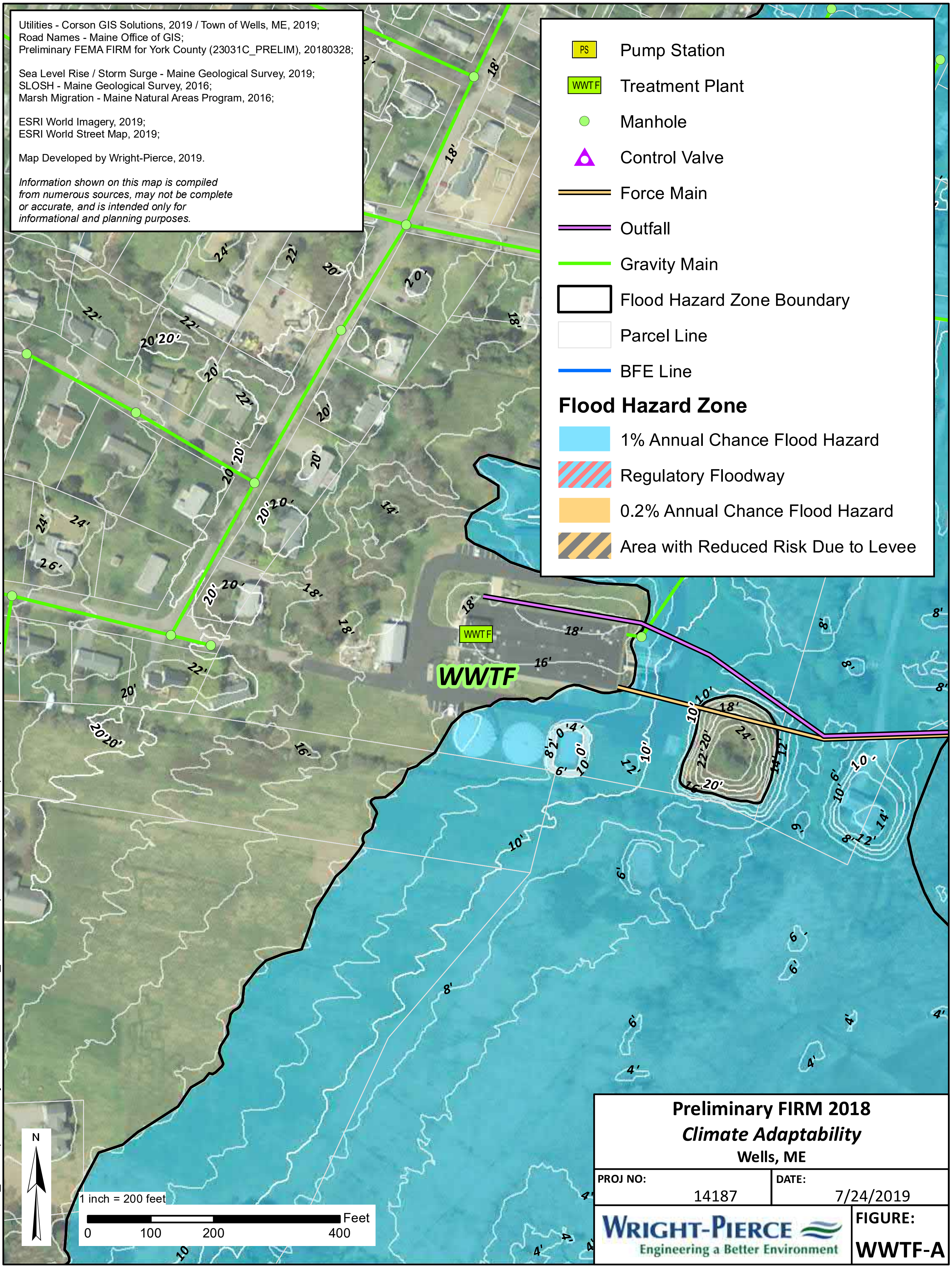

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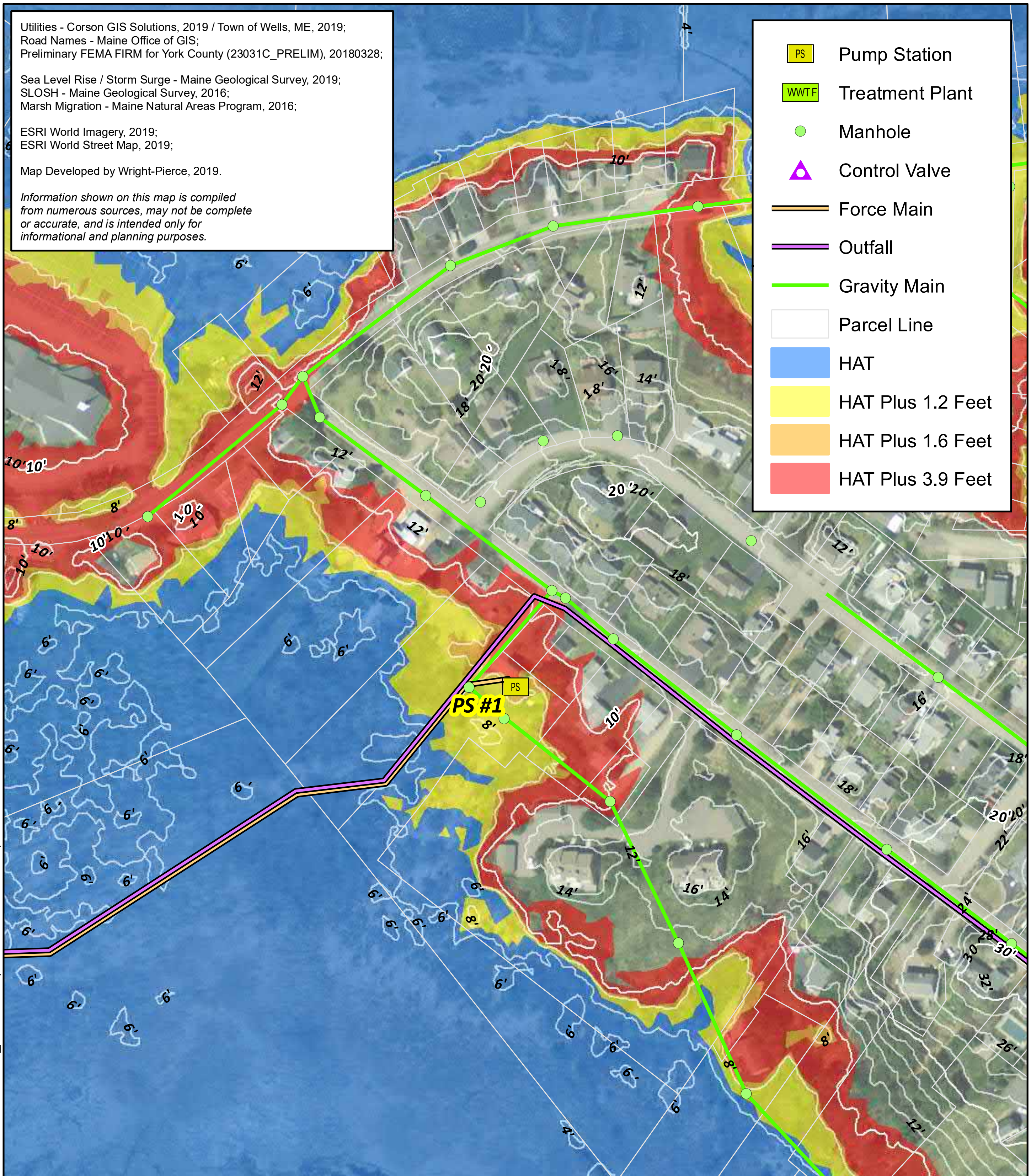
B-2: Potential Sea Level Rise and Storm Surge Maps



Sea Level Rise / Storm Surge

Climate Adaptability

Wells, ME

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14187	7/24/2019

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FIGURE: **PS #1**-B

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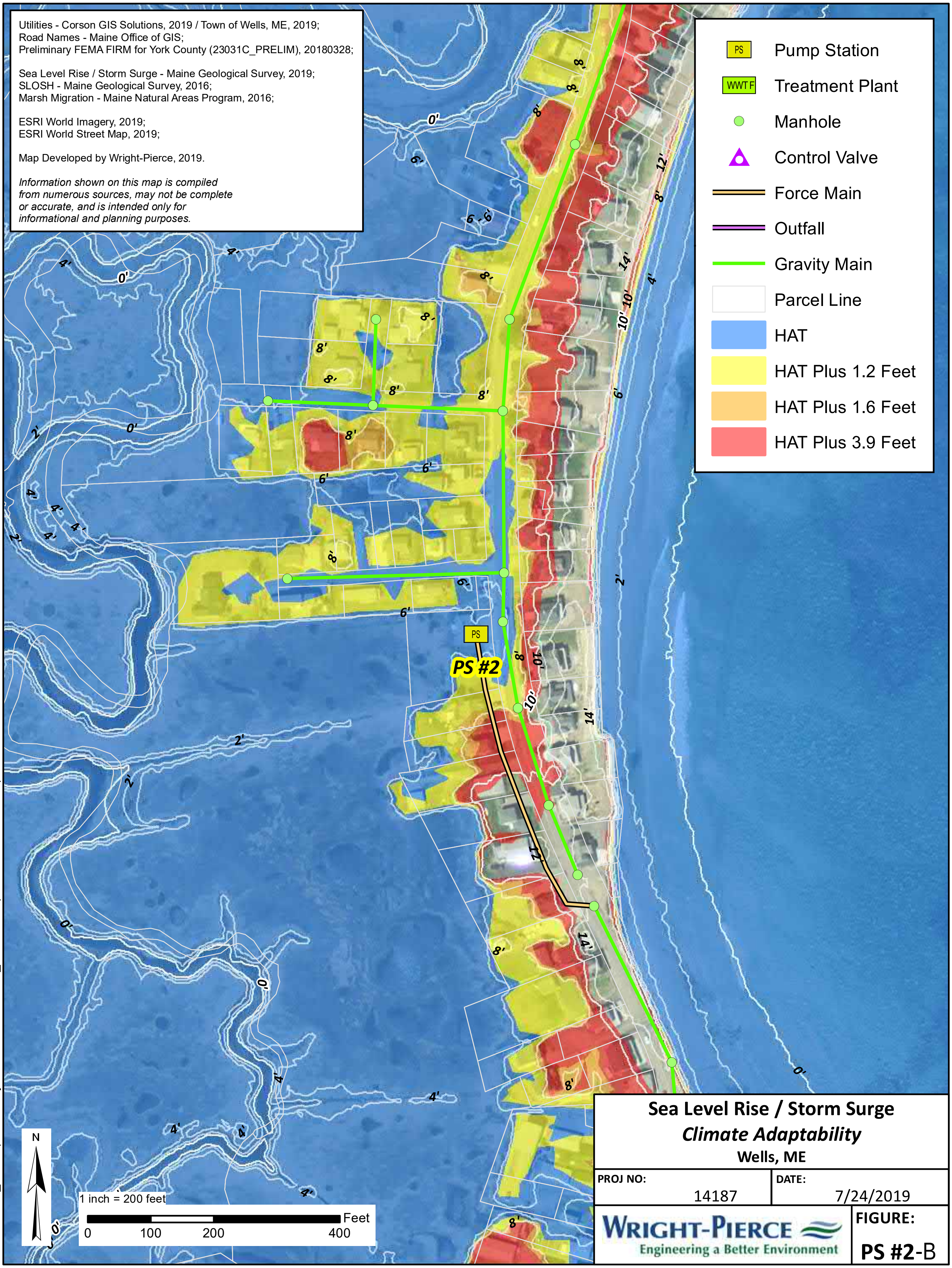

Sea Level Rise / Storm Surge

Climate Adaptability

Wells, ME

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14187	7/24/2019

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FIGURE: **PS #2**-B

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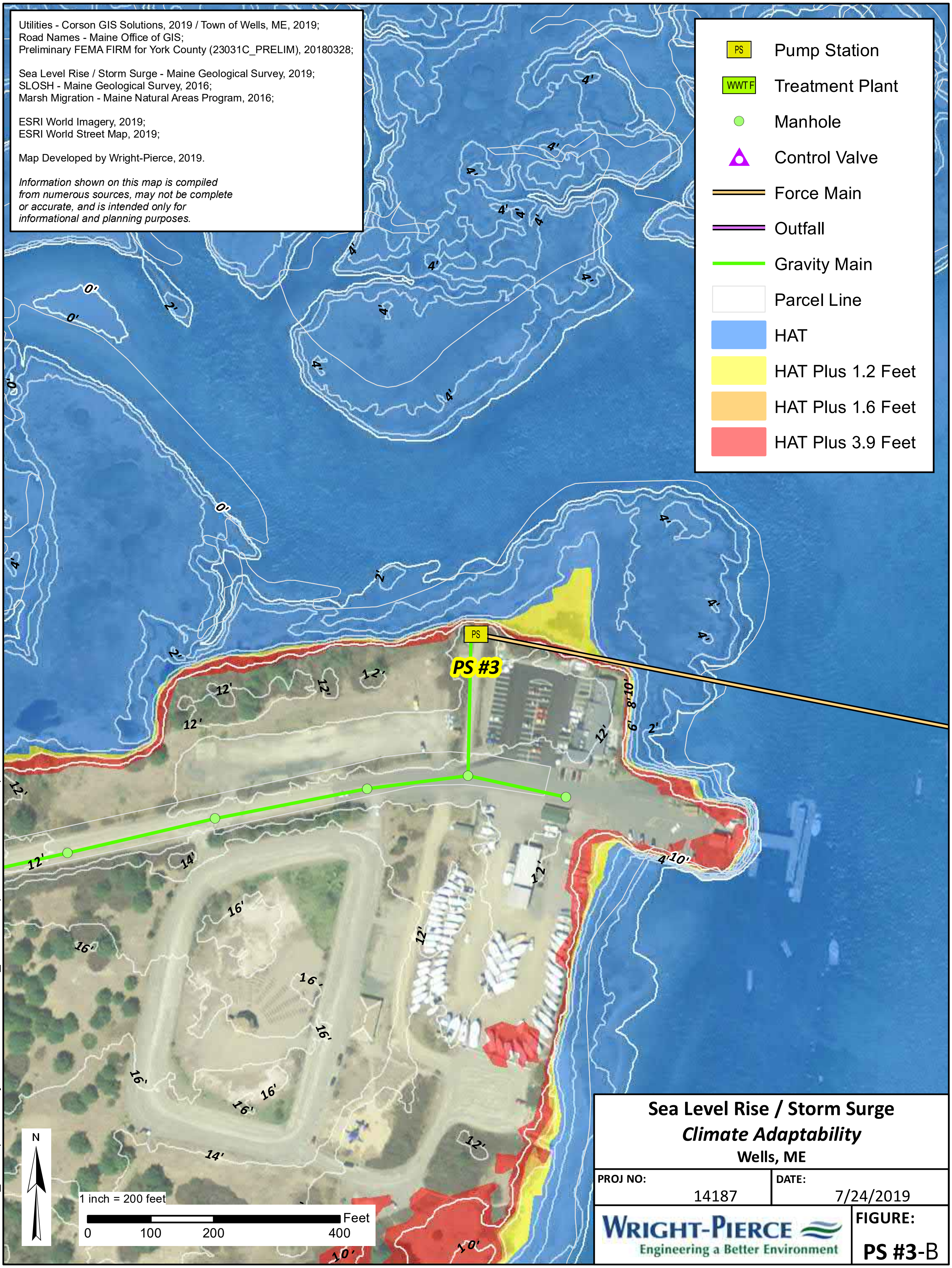

Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
Preliminary FEMA FIRM for York County (23031C_PRELIM), 20180328;

Sea Level Rise / Storm Surge - Maine Geological Survey, 2019;
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ESRI World Street Map, 2019;

Map Developed by Wright-Pierce, 2019.

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Sea Level Rise / Storm Surge
Climate Adaptability
Wells, ME

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FIGURE:
PS #3-B

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Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
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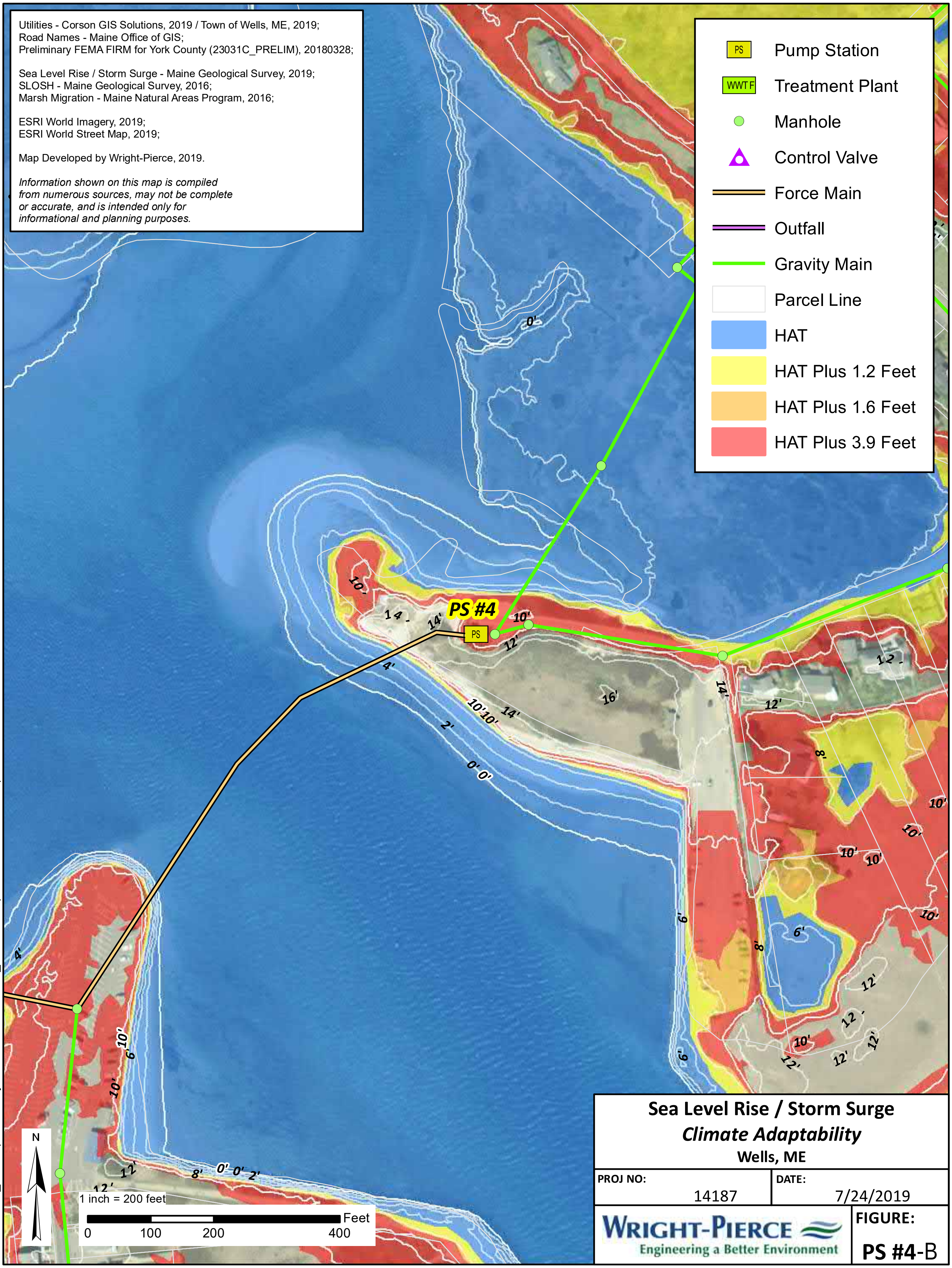

Sea Level Rise / Storm Surge
Climate Adaptability
Wells, ME

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FIGURE: **PS #4**-B

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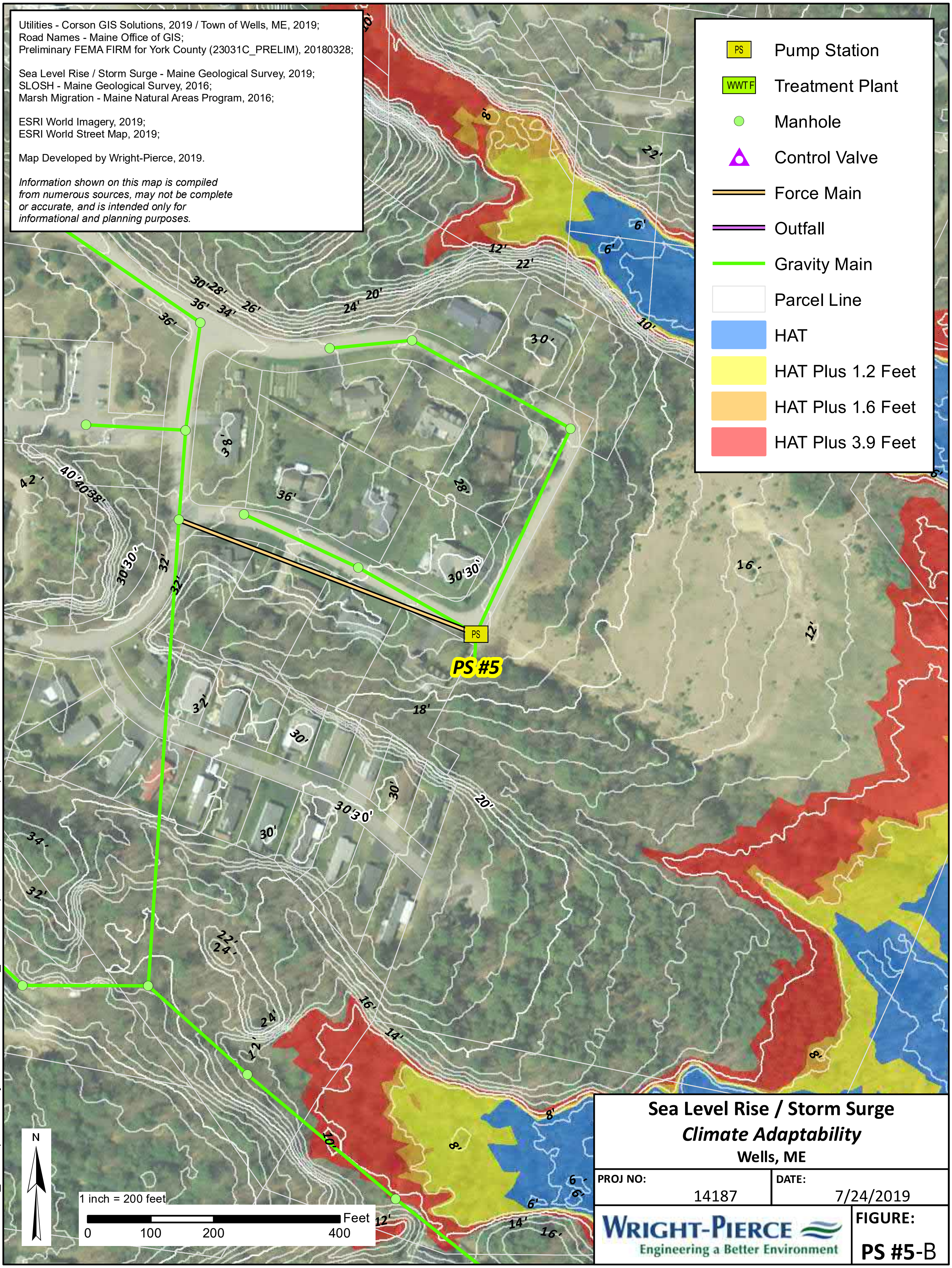

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ESRI World Street Map, 2019;

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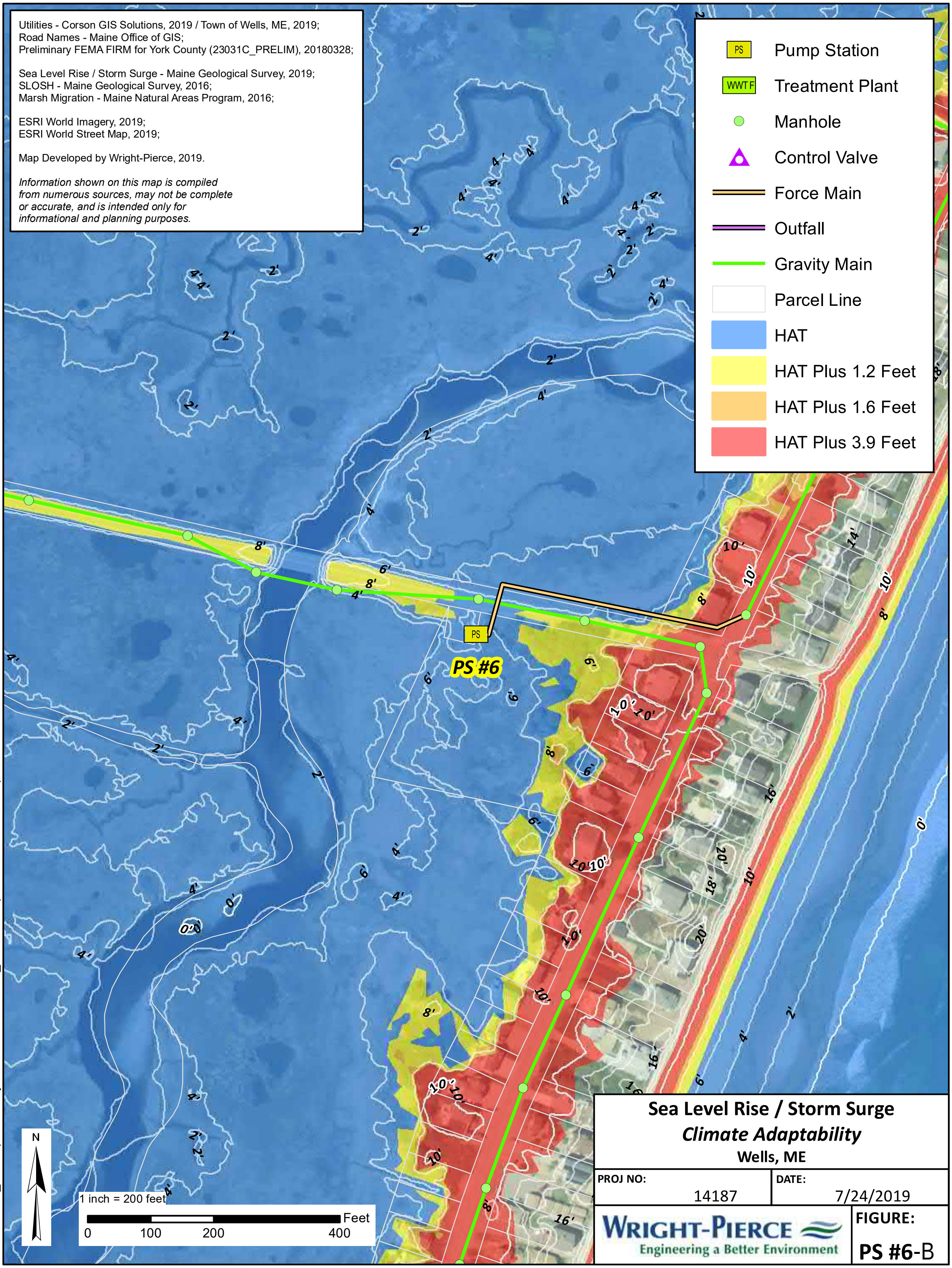

Sea Level Rise / Storm Surge
Climate Adaptability
Wells, ME

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14187	7/24/2019

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FIGURE:
PS #6-B

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Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
Preliminary FEMA FIRM for York County (23031C_PRELIM), 20180328;

Sea Level Rise / Storm Surge - Maine Geological Survey, 2019;
SLOSH - Maine Geological Survey, 2016;
Marsh Migration - Maine Natural Areas Program, 2016;

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ESRI World Street Map, 2019;

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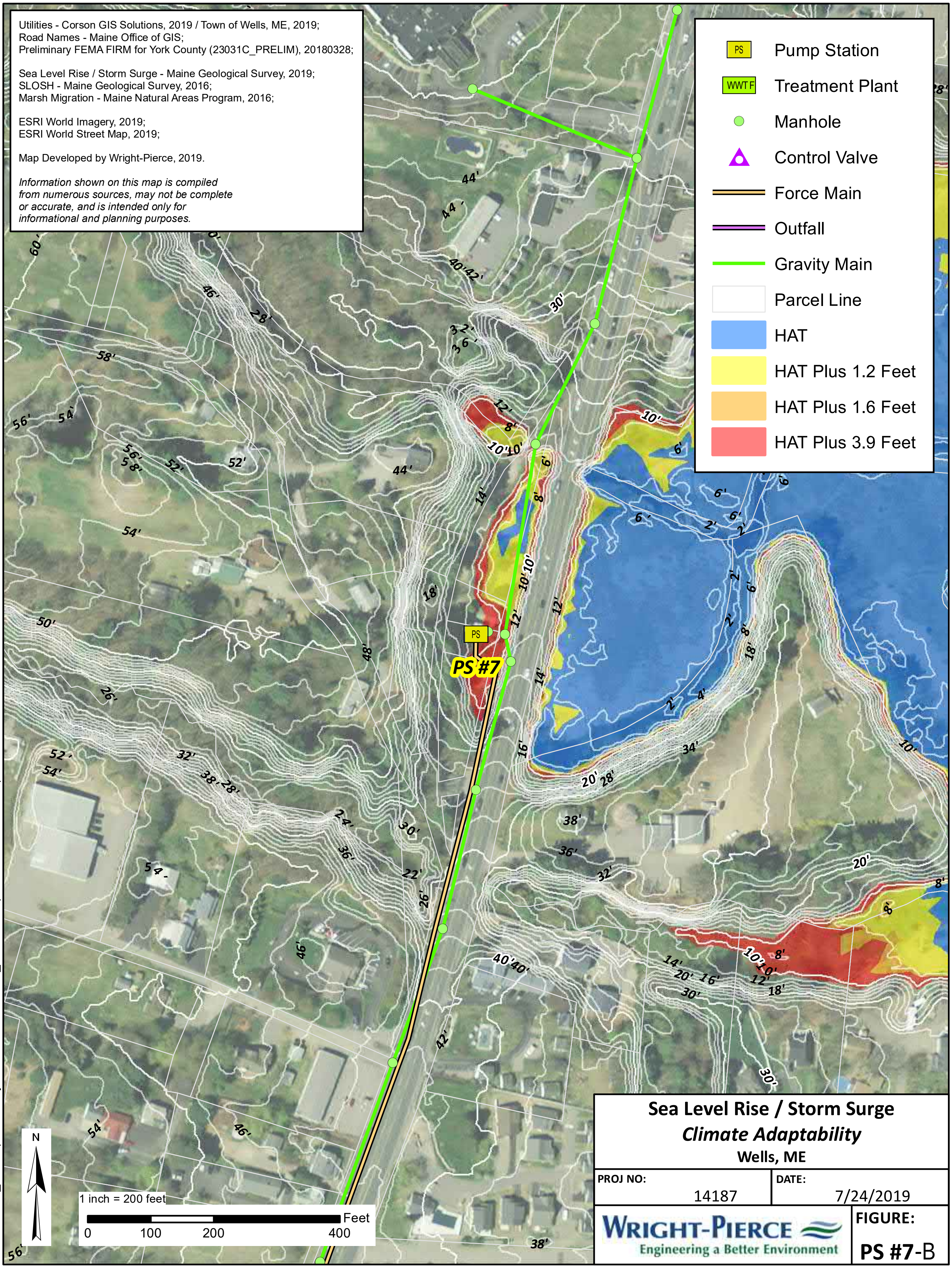

Legend	
PS	Pump Station
WWTF	Treatment Plant
	Manhole
	Control Valve
	Force Main
	Outfall
	Gravity Main
	Parcel Line
	HAT
	HAT Plus 1.2 Feet
	HAT Plus 1.6 Feet
	HAT Plus 3.9 Feet

Sea Level Rise / Storm Surge
Climate Adaptability
Wells, ME

PROJ NO:	DATE:
14187	7/24/2019

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FIGURE: **PS #7**-B

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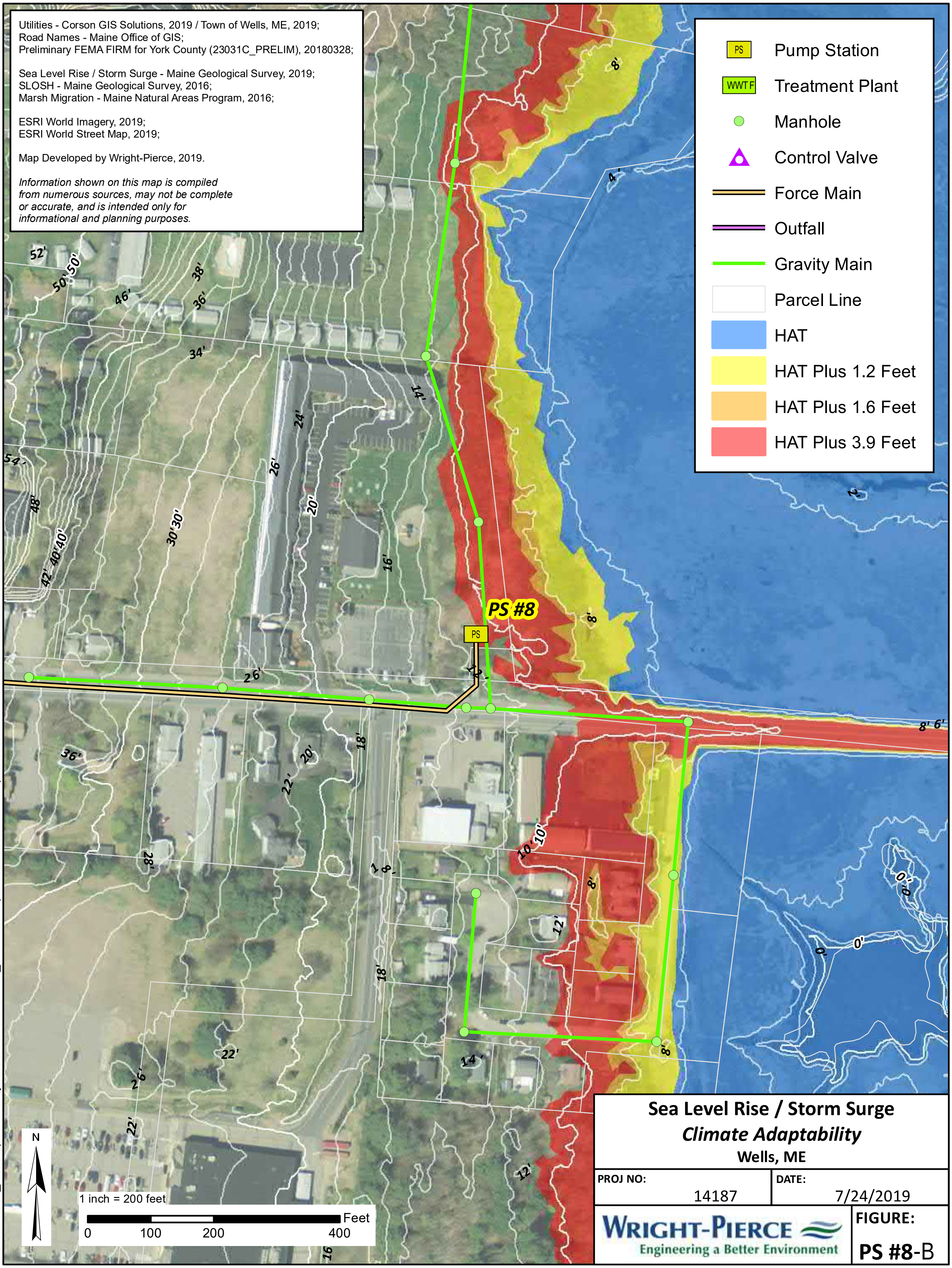

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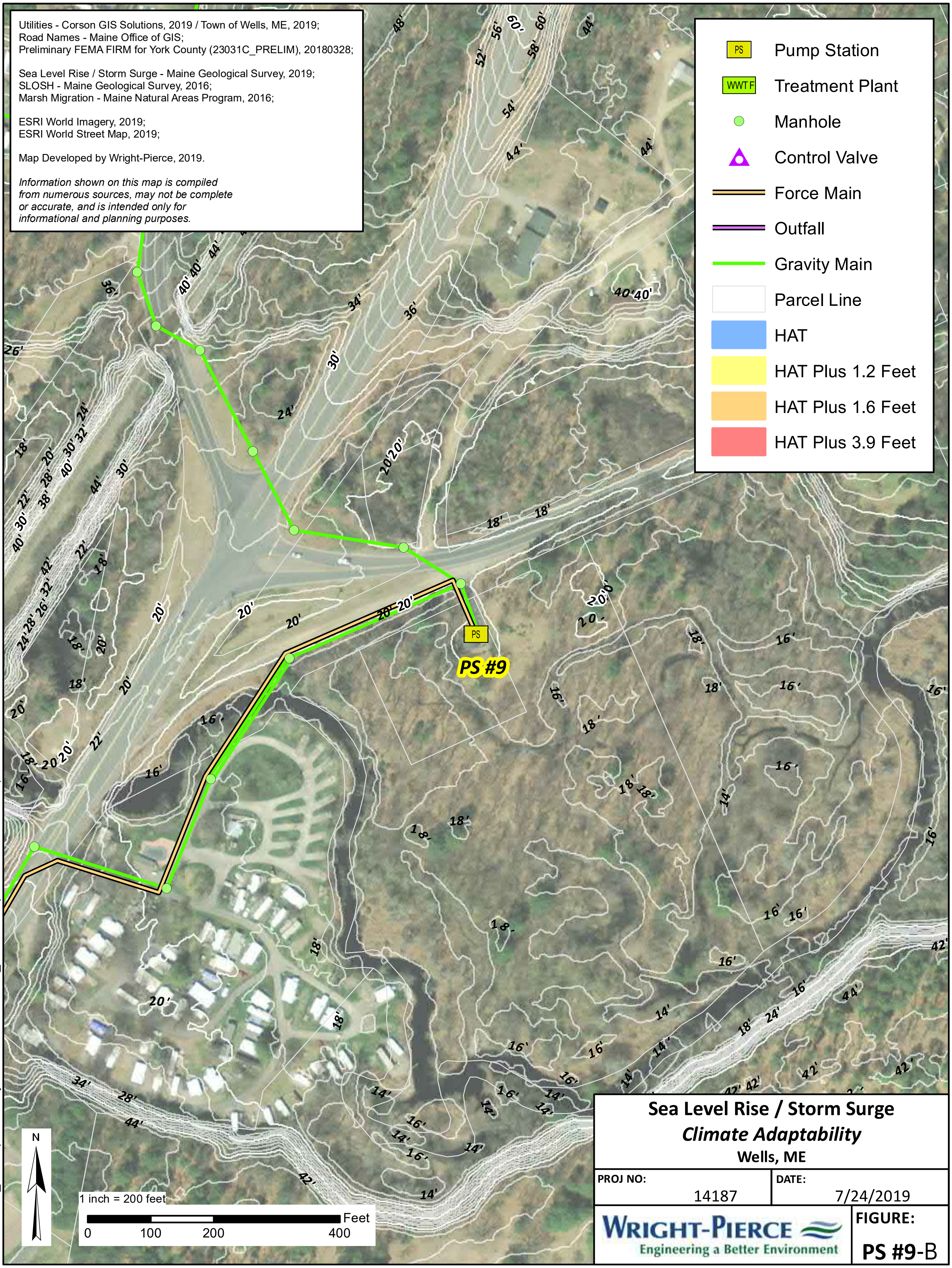

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Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
Preliminary FEMA FIRM for York County (23031C_PRELIM), 20180328;

Sea Level Rise / Storm Surge - Maine Geological Survey, 2019;
SLOSH - Maine Geological Survey, 2016;
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ESRI World Street Map, 2019;

Map Developed by Wright-Pierce, 2019.

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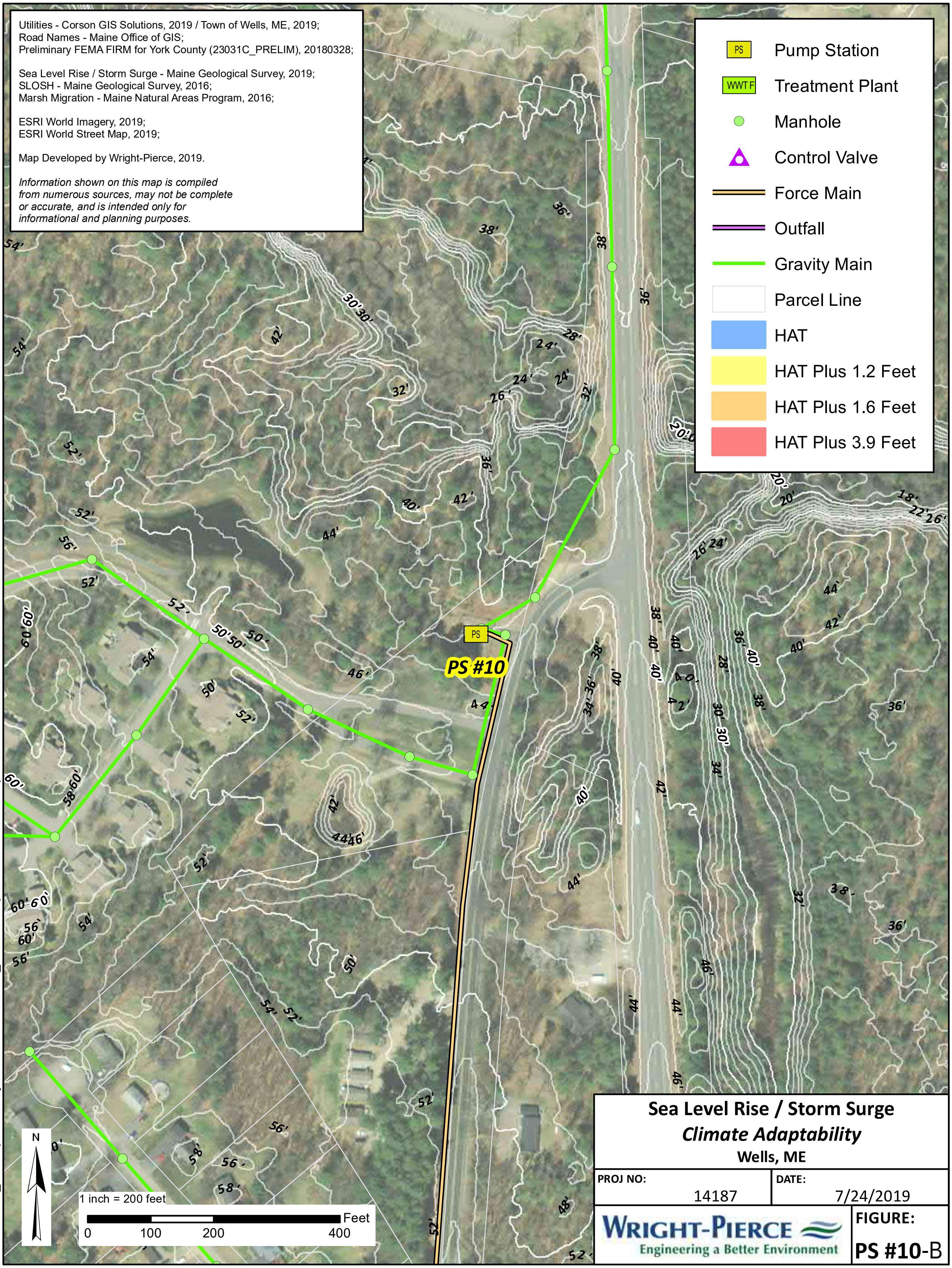

PS	Pump Station
WWTF	Treatment Plant
	Manhole
	Control Valve
	Force Main
	Outfall
	Gravity Main
	Parcel Line
	HAT
	HAT Plus 1.2 Feet
	HAT Plus 1.6 Feet
	HAT Plus 3.9 Feet

Sea Level Rise / Storm Surge
Climate Adaptability
Wells, ME

PROJ NO:	DATE:
14187	7/24/2019

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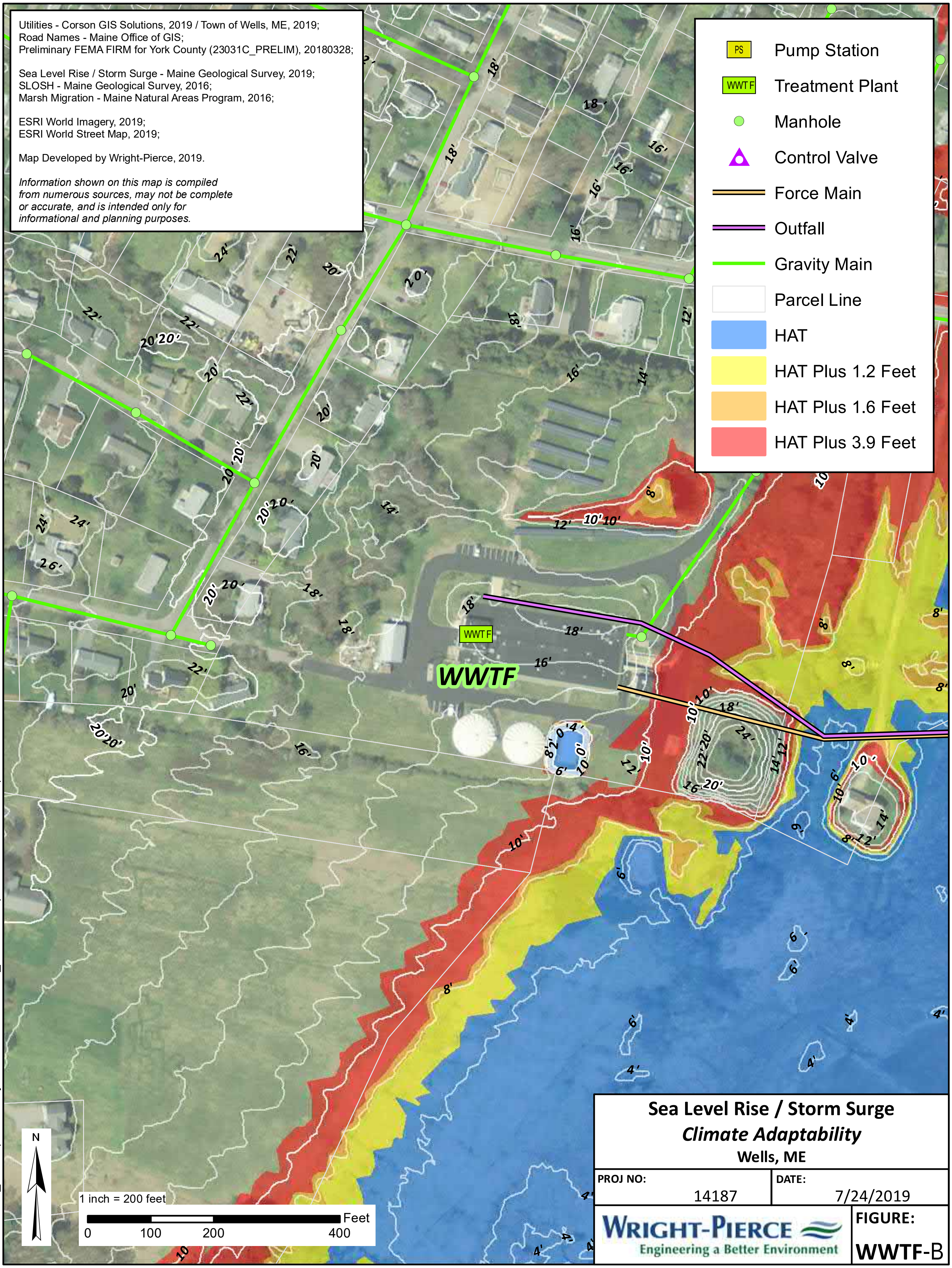
Engineering a Better Environment

FIGURE:
PS #10-B

TAH W:\GIS_Development\Projects\ME\Wells\14187_ClimateAdaptationPlan\MXDs\Mapbook-X-X-PS-SLR-v1-8x11-P.mxd



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B-3: Potential Marsh Migration from Sea Level Rise Maps

Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
Preliminary FEMA FIRM for York County (23031C_PRELIM), 20180328;

Sea Level Rise / Storm Surge - Maine Geological Survey, 2019;
SLOSH - Maine Geological Survey, 2016;
Marsh Migration - Maine Natural Areas Program, 2016;

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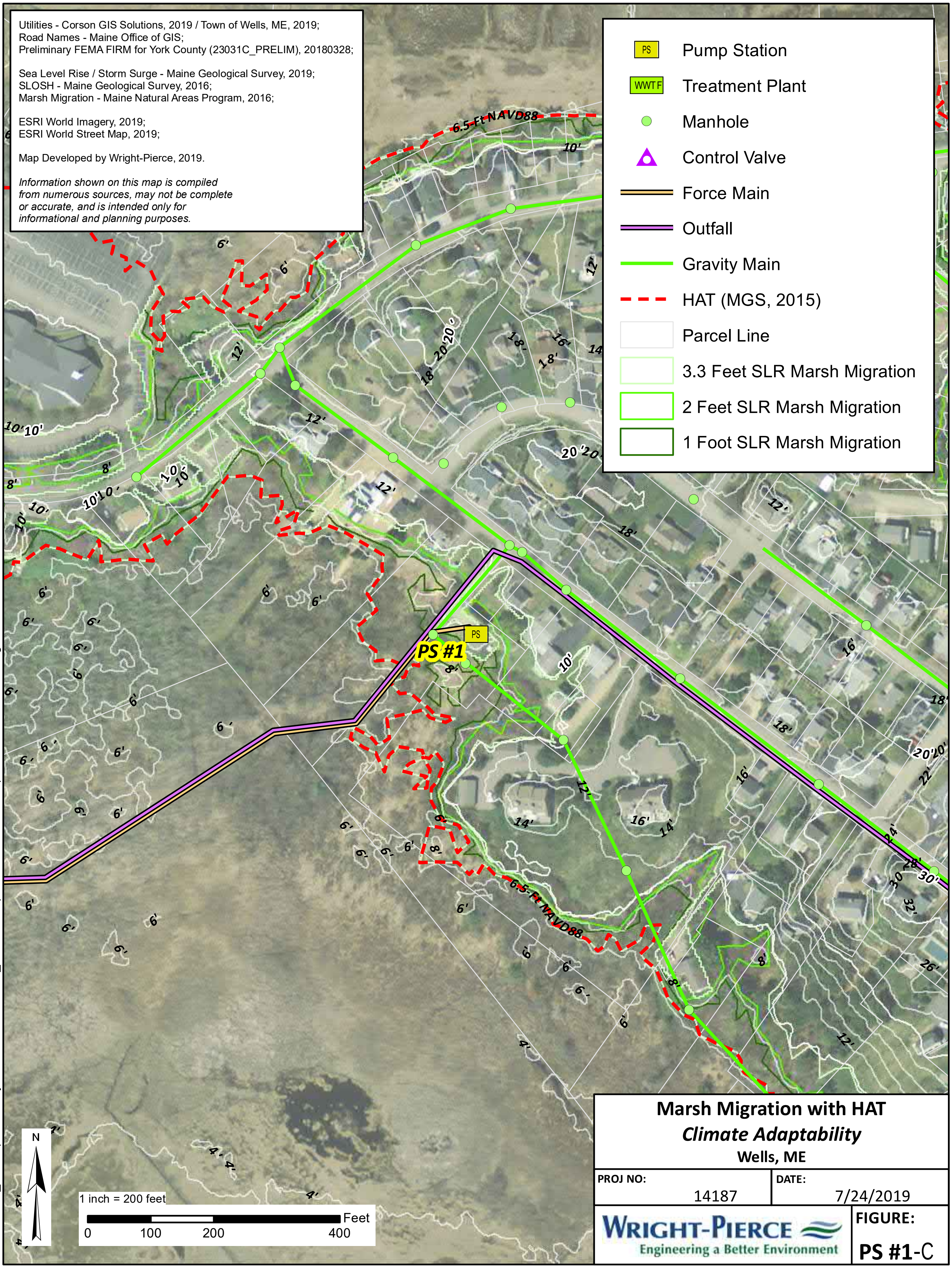

Marsh Migration with HAT

Climate Adaptability

Wells, ME

PROJ NO:	DATE:
14187	7/24/2019

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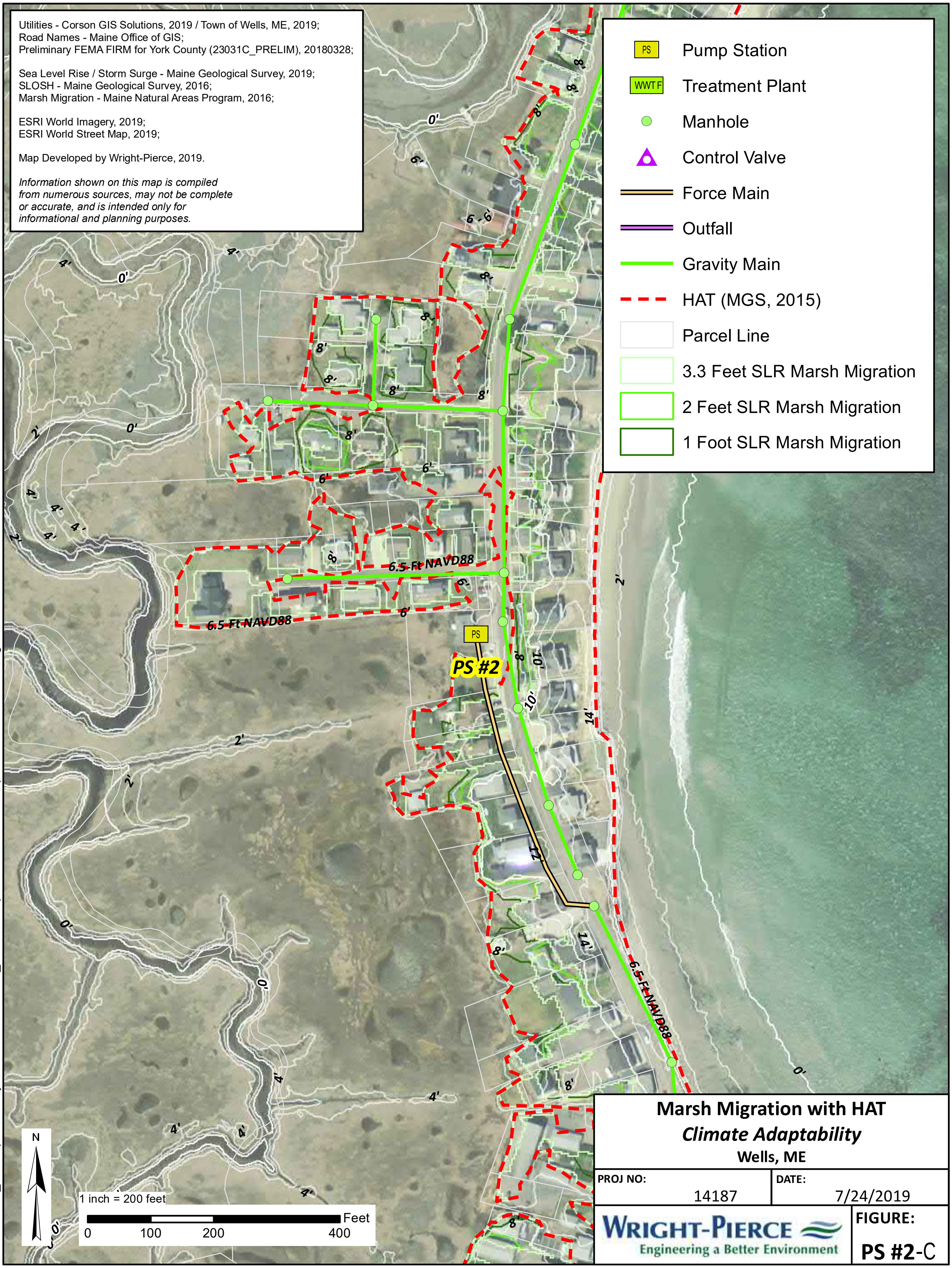
FIGURE:
PS #1-C

TAH W:\GIS_Development\Projects\ME\Wells\14187_ClimateAdaptationPlan\MXDs\Mapbook-X-X-PS-MarshMigrationHAT-v1-8x11-P.mxd



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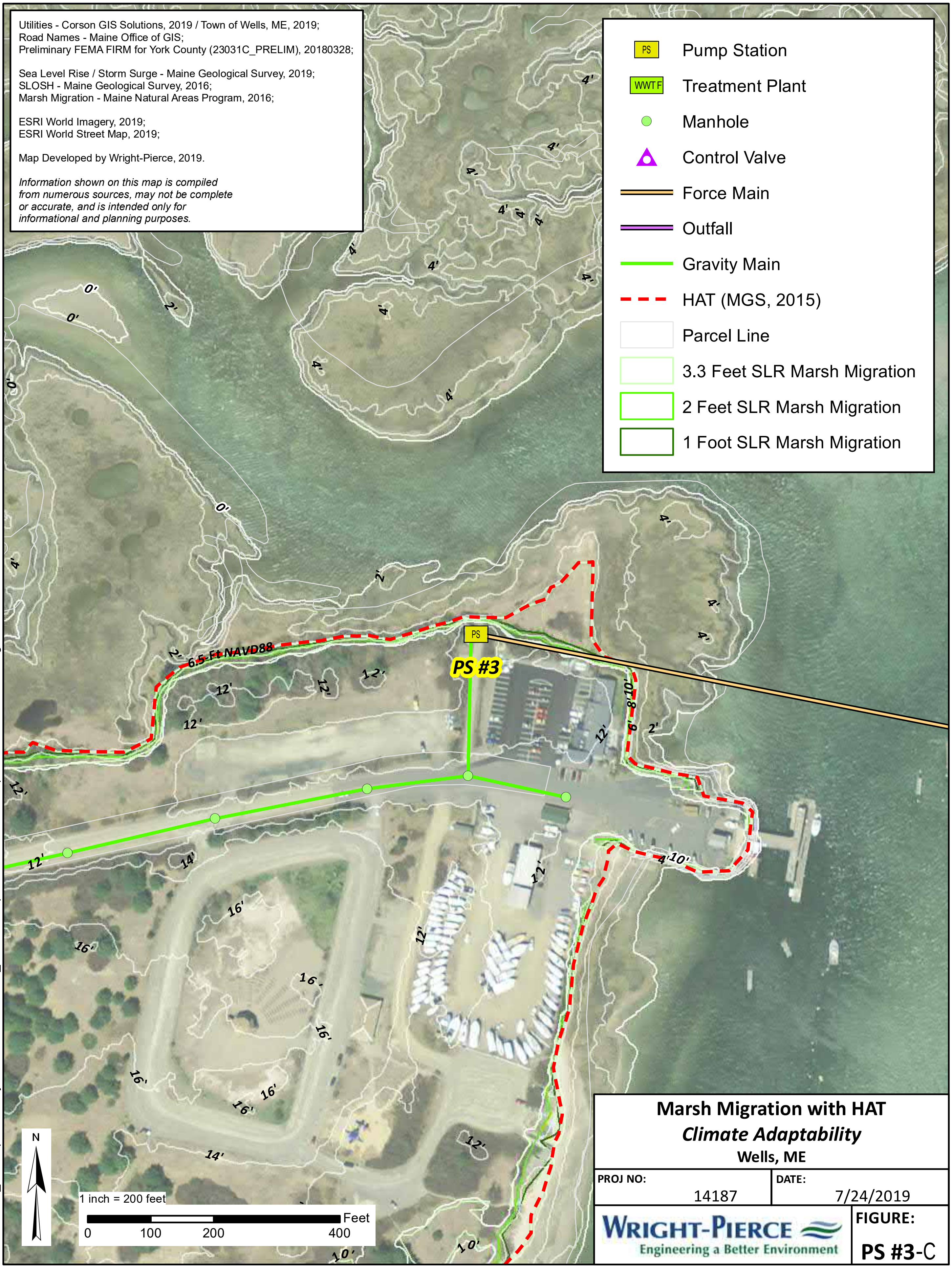

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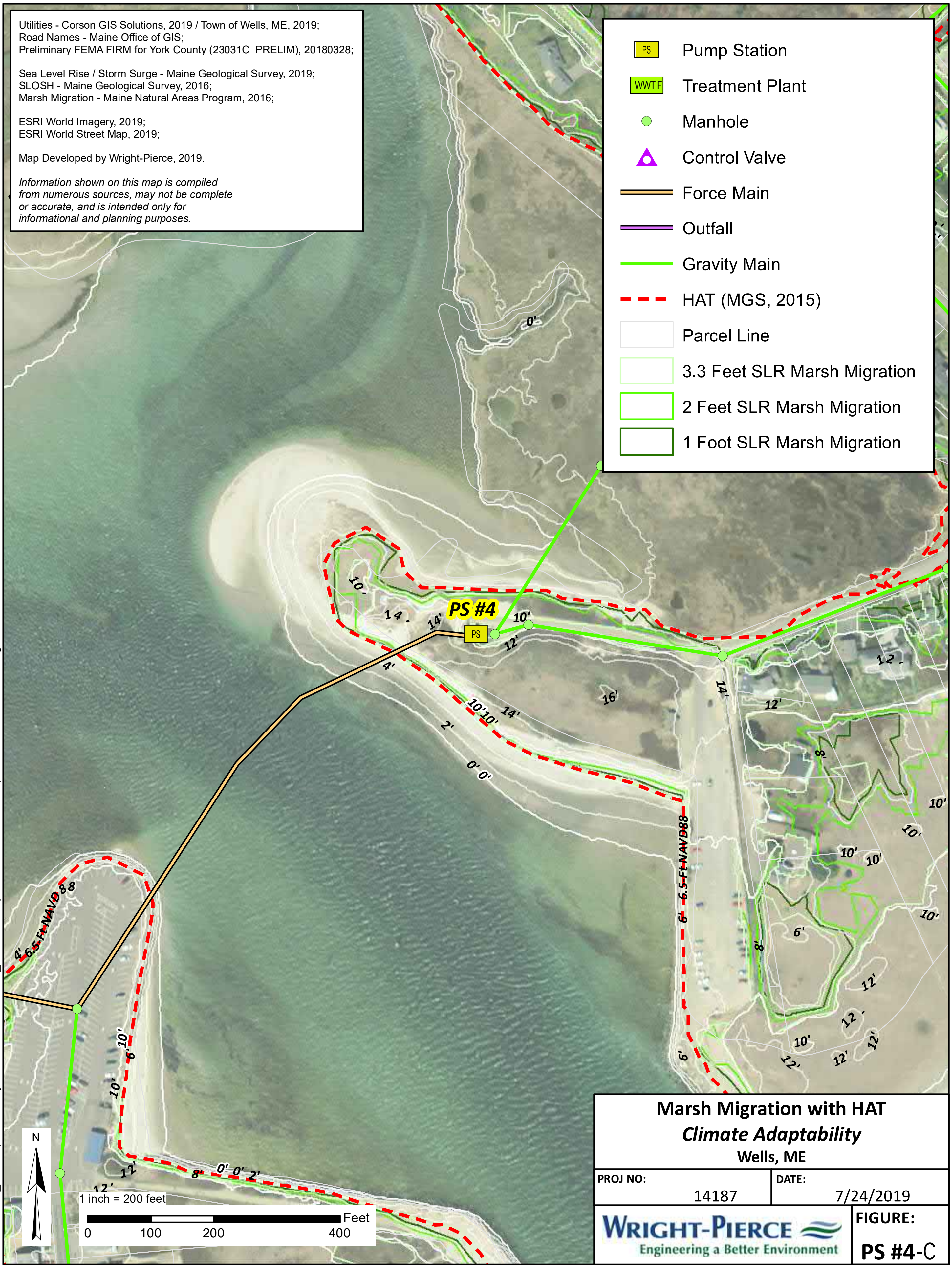

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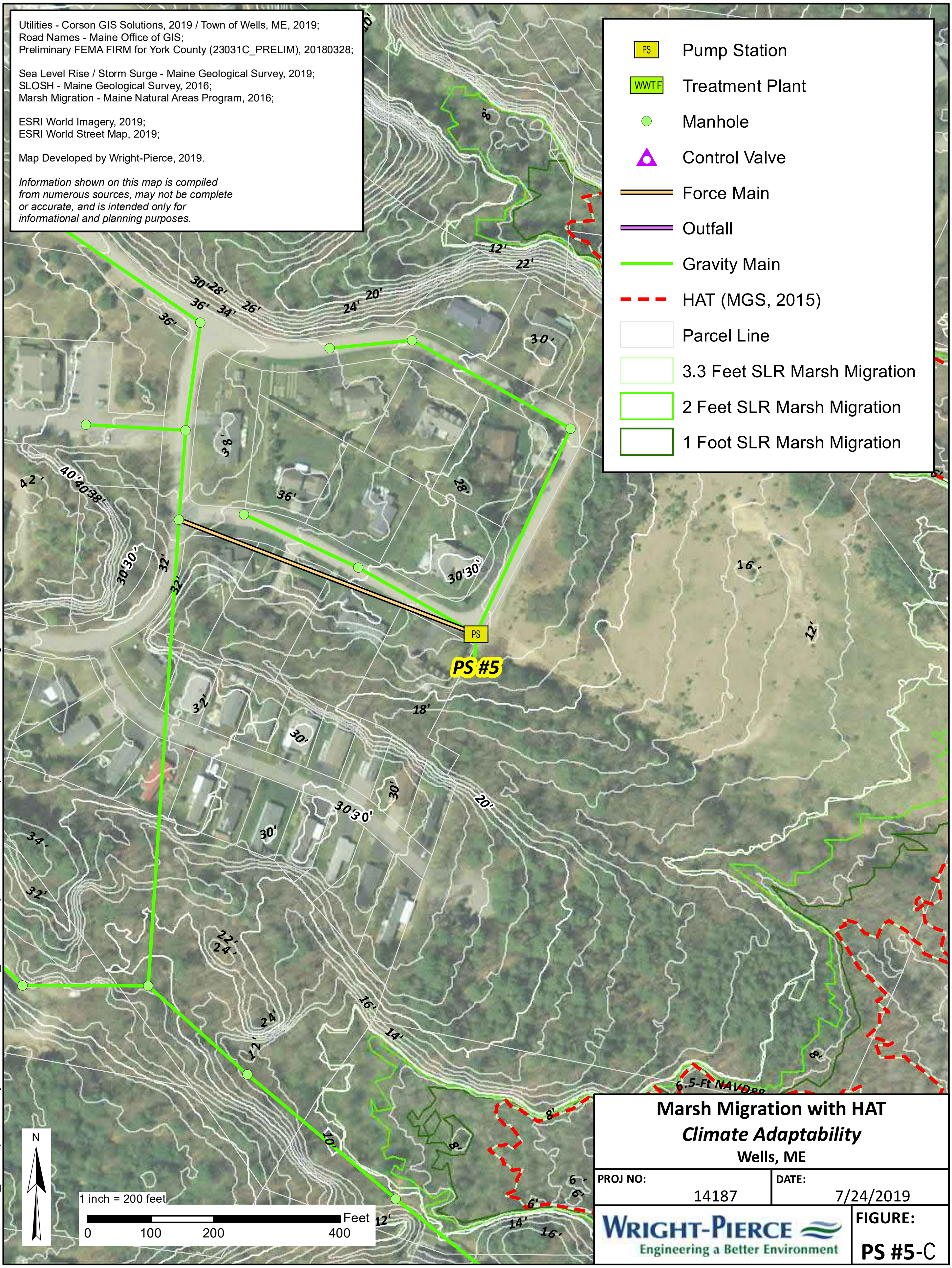

Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
Preliminary FEMA FIRM for York County (23031C_PRELIM), 20180328;

Sea Level Rise / Storm Surge - Maine Geological Survey, 2019;
SLOSH - Maine Geological Survey, 2016;
Marsh Migration - Maine Natural Areas Program, 2016;

ESRI World Imagery, 2019;
ESRI World Street Map, 2019;

Map Developed by Wright-Pierce, 2019.

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PS	Pump Station
WWTF	Treatment Plant
	Manhole
	Control Valve
	Force Main
	Outfall
	Gravity Main
	HAT (MGS, 2015)
	Parcel Line
	3.3 Feet SLR Marsh Migration
	2 Feet SLR Marsh Migration
	1 Foot SLR Marsh Migration

Marsh Migration with HAT
Climate Adaptability
Wells, ME

PROJ NO:	DATE:
14187	7/24/2019

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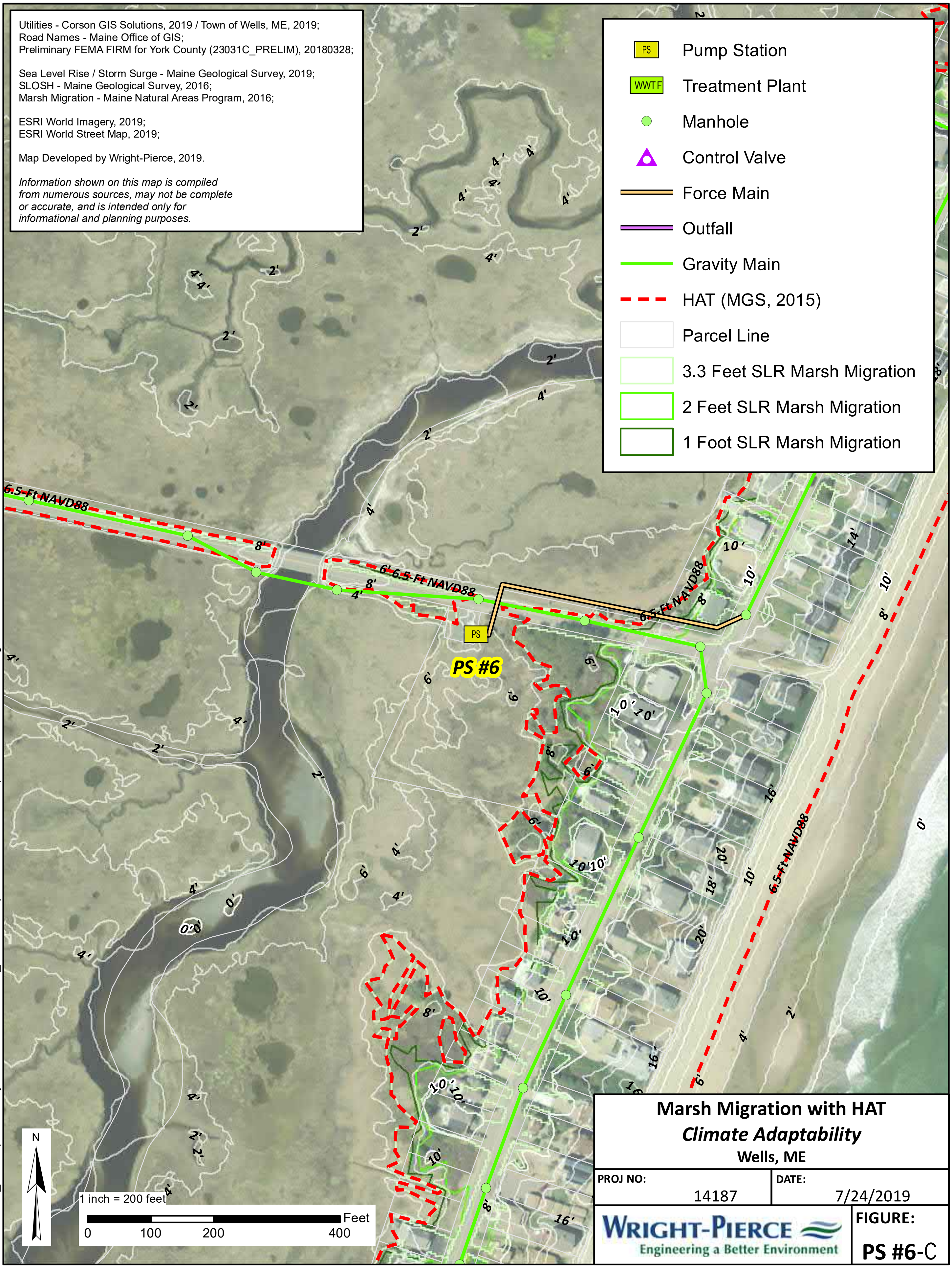
FIGURE: PS #5-C

TAH W:\GIS_Development\Projects\ME\Wells\14187_ClimateAdaptationPlan\MXDs\Mapbook-X-X-PS-MarshMigrationHAT-v1-8x11-P.mxd



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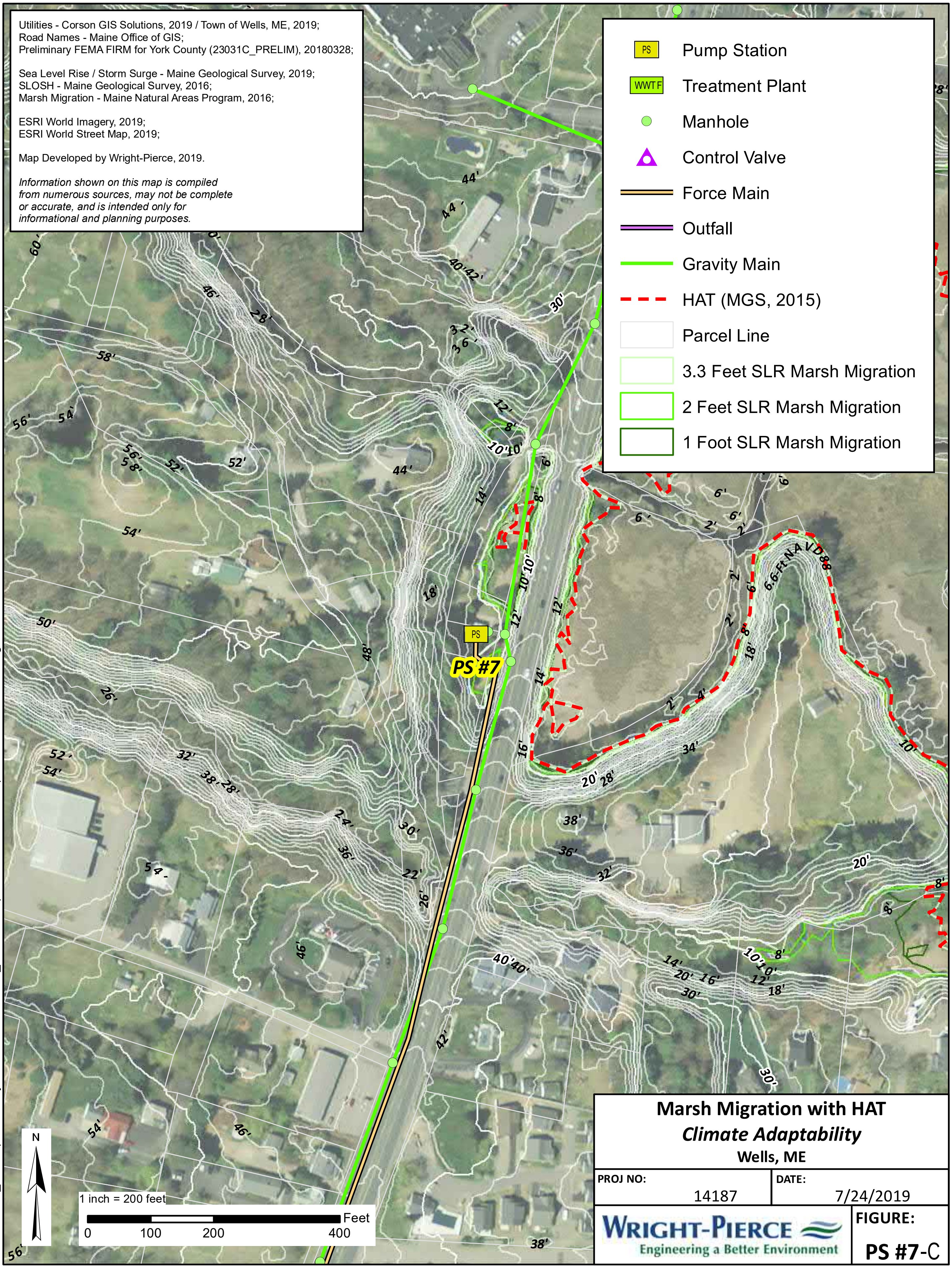

Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
Preliminary FEMA FIRM for York County (23031C_PRELIM), 20180328;

Sea Level Rise / Storm Surge - Maine Geological Survey, 2019;
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Marsh Migration with HAT
Climate Adaptability
Wells, ME

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14187	7/24/2019

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FIGURE:
PS #7-C

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Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
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Preliminary FEMA FIRM for York County (23031C_PRELIM), 20180328;

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ESRI World Street Map, 2019;

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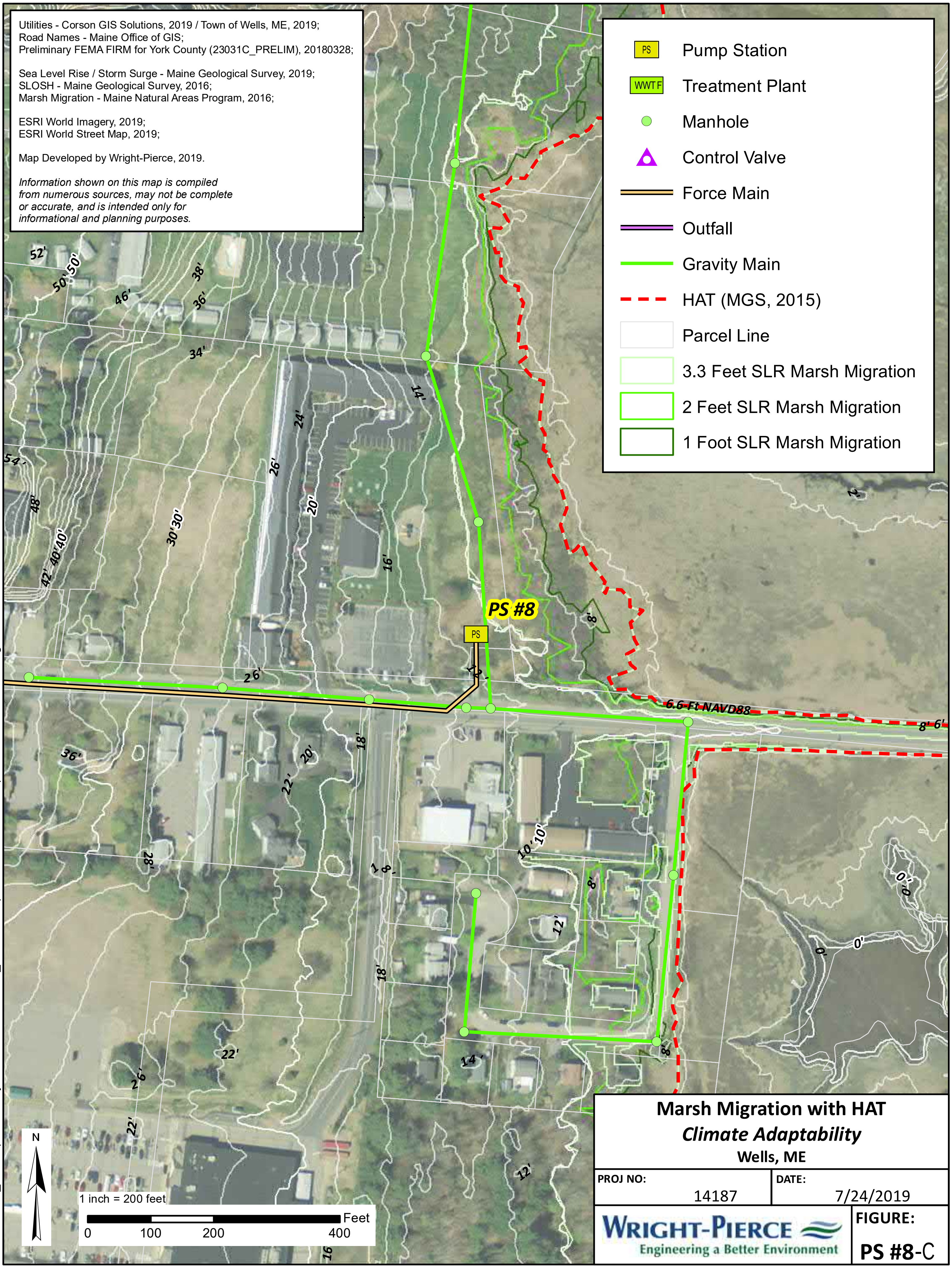

PS	Pump Station
WWTF	Treatment Plant
	Manhole
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	Force Main
	Outfall
	Gravity Main
	HAT (MGS, 2015)
	Parcel Line
	3.3 Feet SLR Marsh Migration
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Marsh Migration with HAT

Climate Adaptability

Wells, ME

PROJ NO:	DATE:
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FIGURE: **PS #8-C**

TAH W:\GIS_Development\Projects\ME\Wells\14187_ClimateAdaptationPlan\MXDs\Mapbook-X-X-PS-MarshMigrationHAT-v1-8x11-P.mxd

Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
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Marsh Migration with HAT
Climate Adaptability
Wells, ME

PROJ NO: 14187	**DATE:** 7/24/2019
WRIGHT-PIERCE Engineering a Better Environment	**FIGURE:** **PS #9**-C

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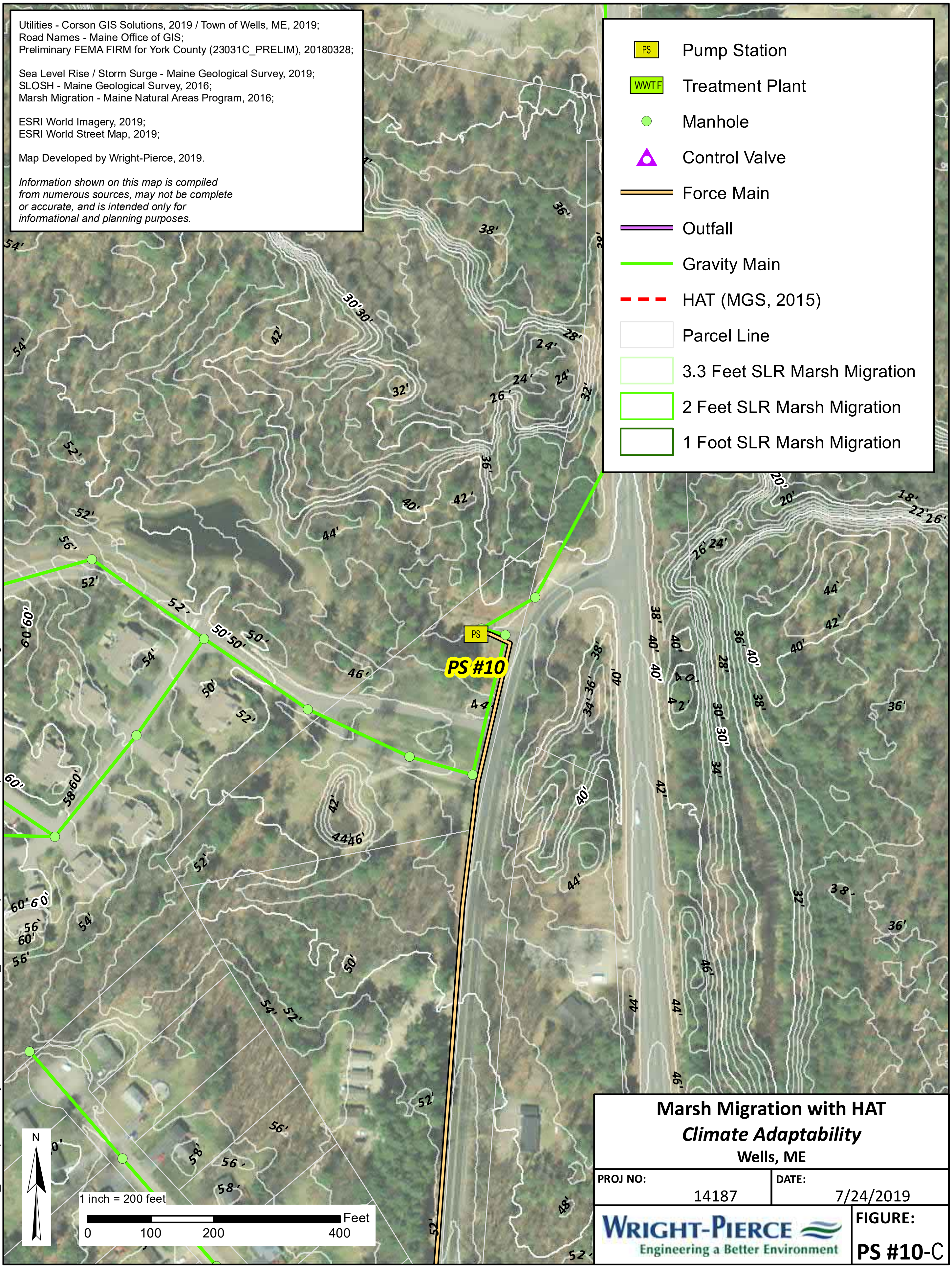

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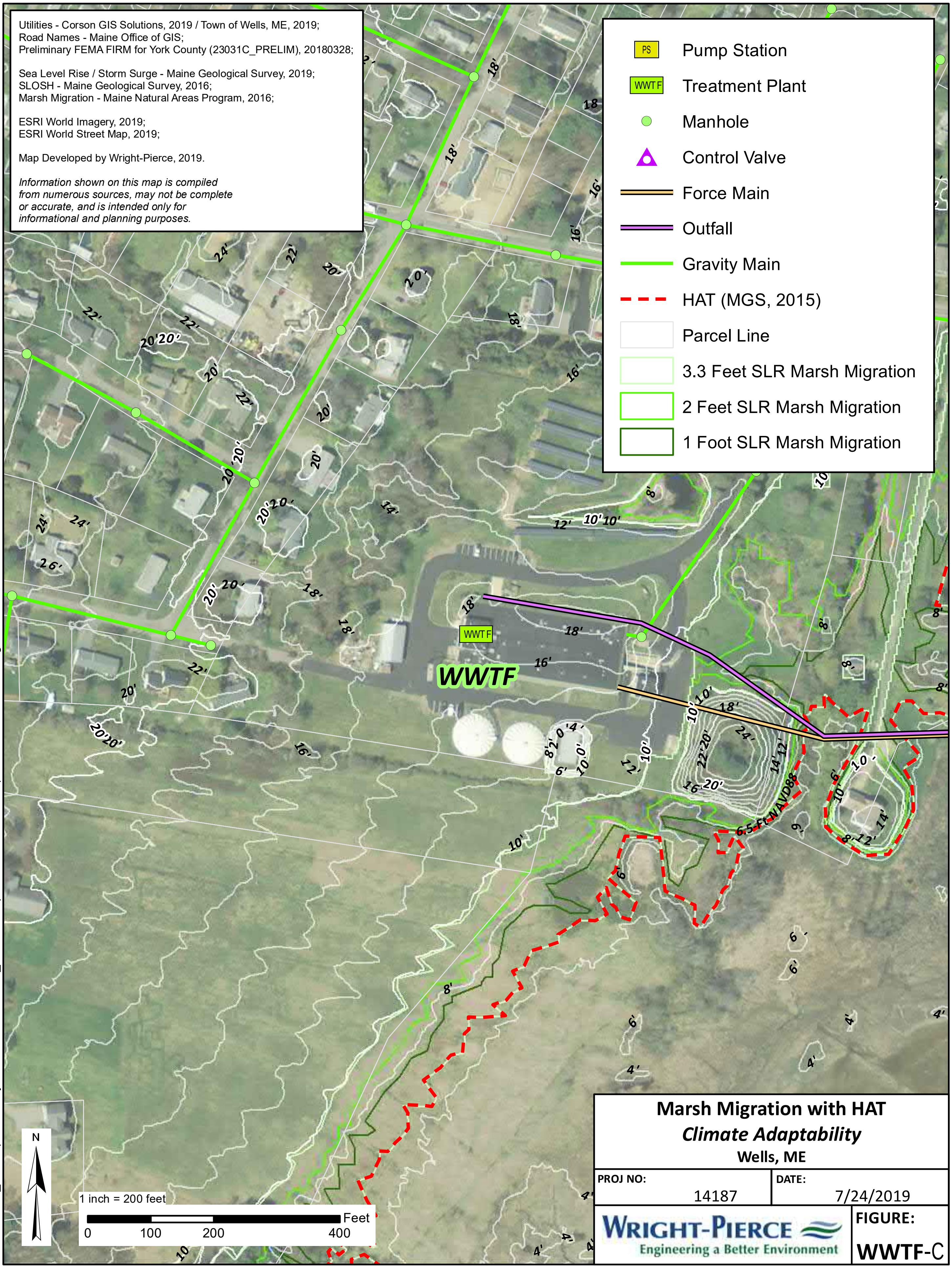

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B-4: Sea, Lake and Overland Surge from Hurricane (SLOSH) Model Maps

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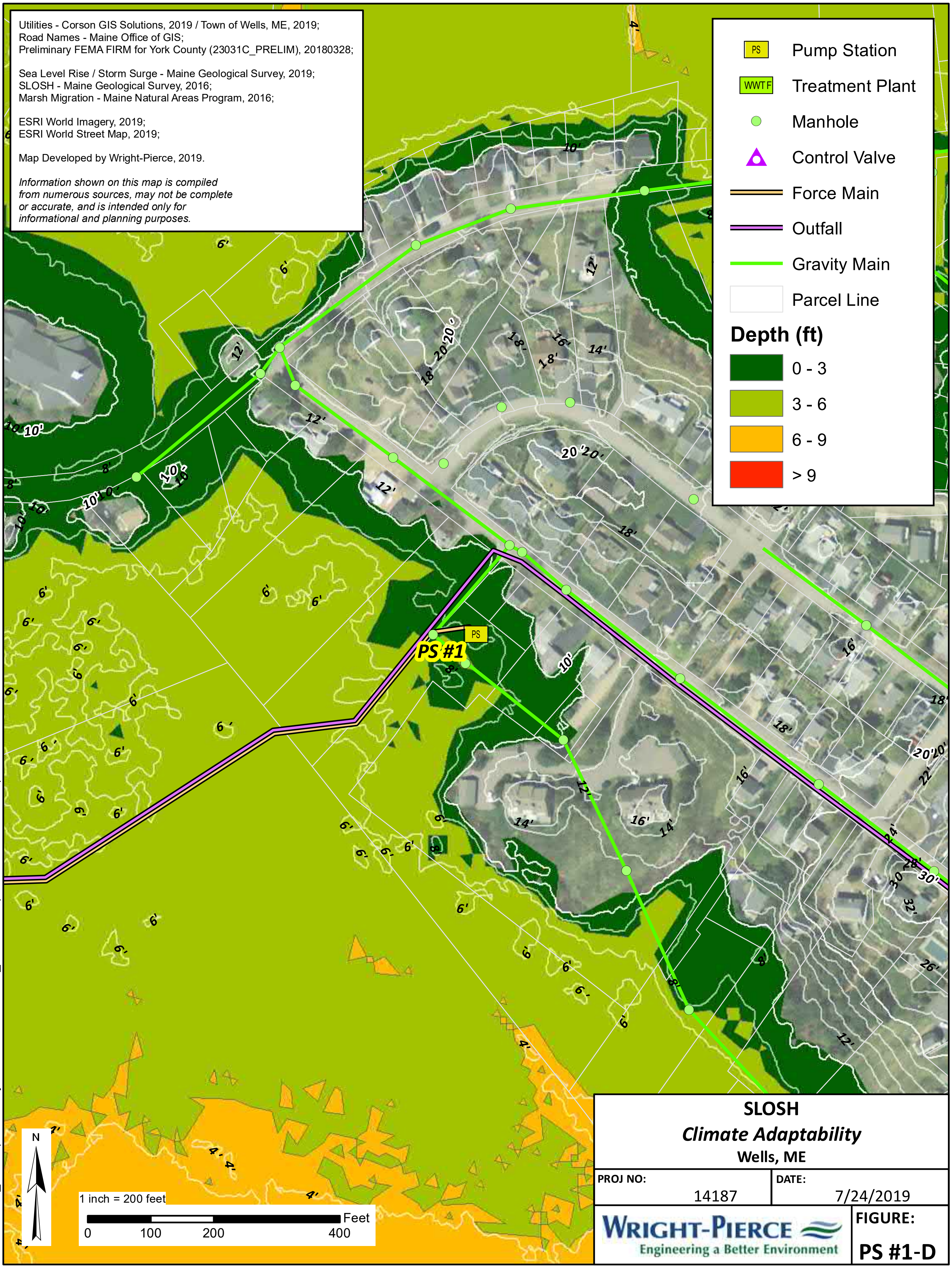

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SLOSH

Climate Adaptability

Wells, ME

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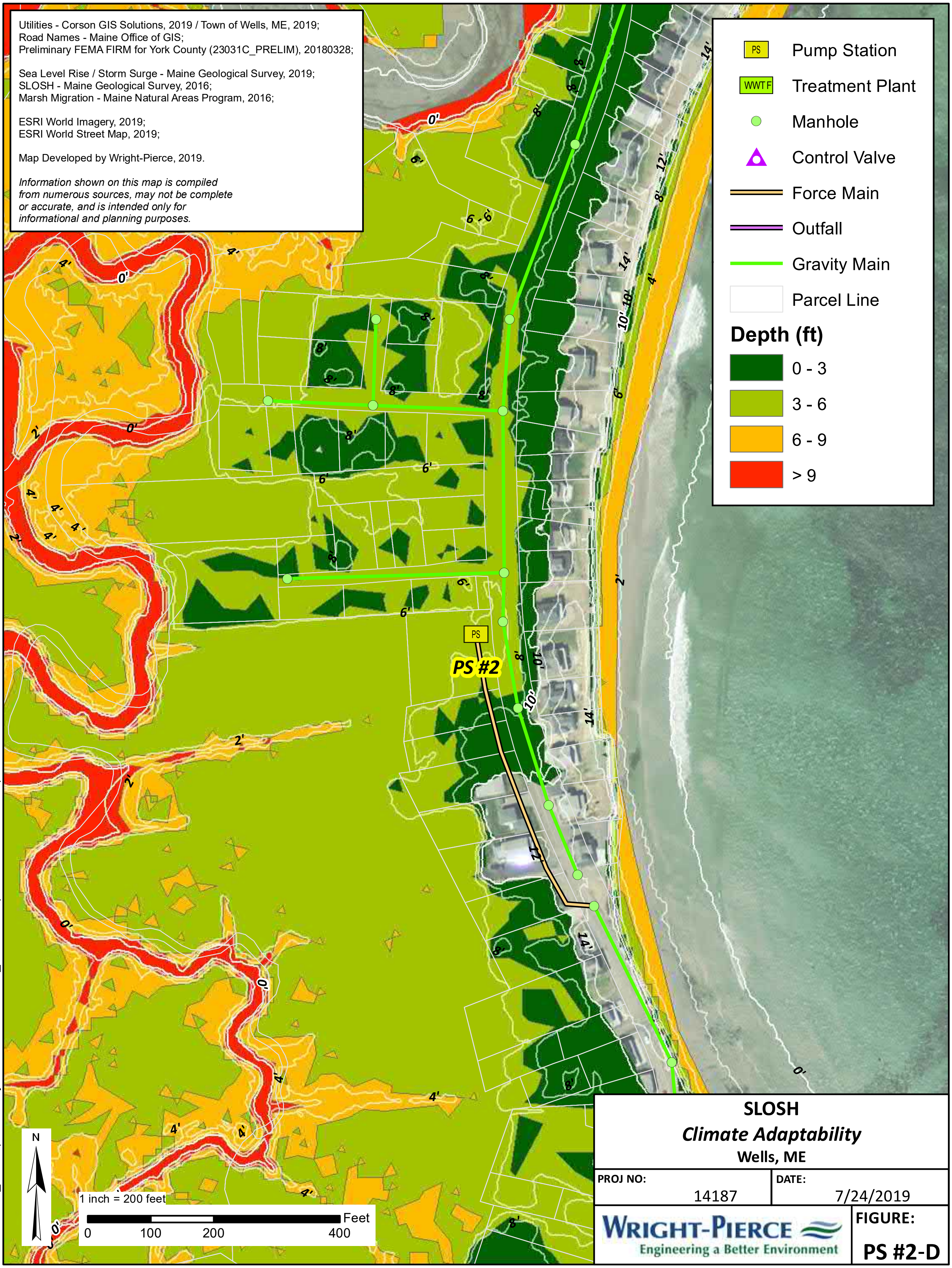
FIGURE: **PS #1-D**



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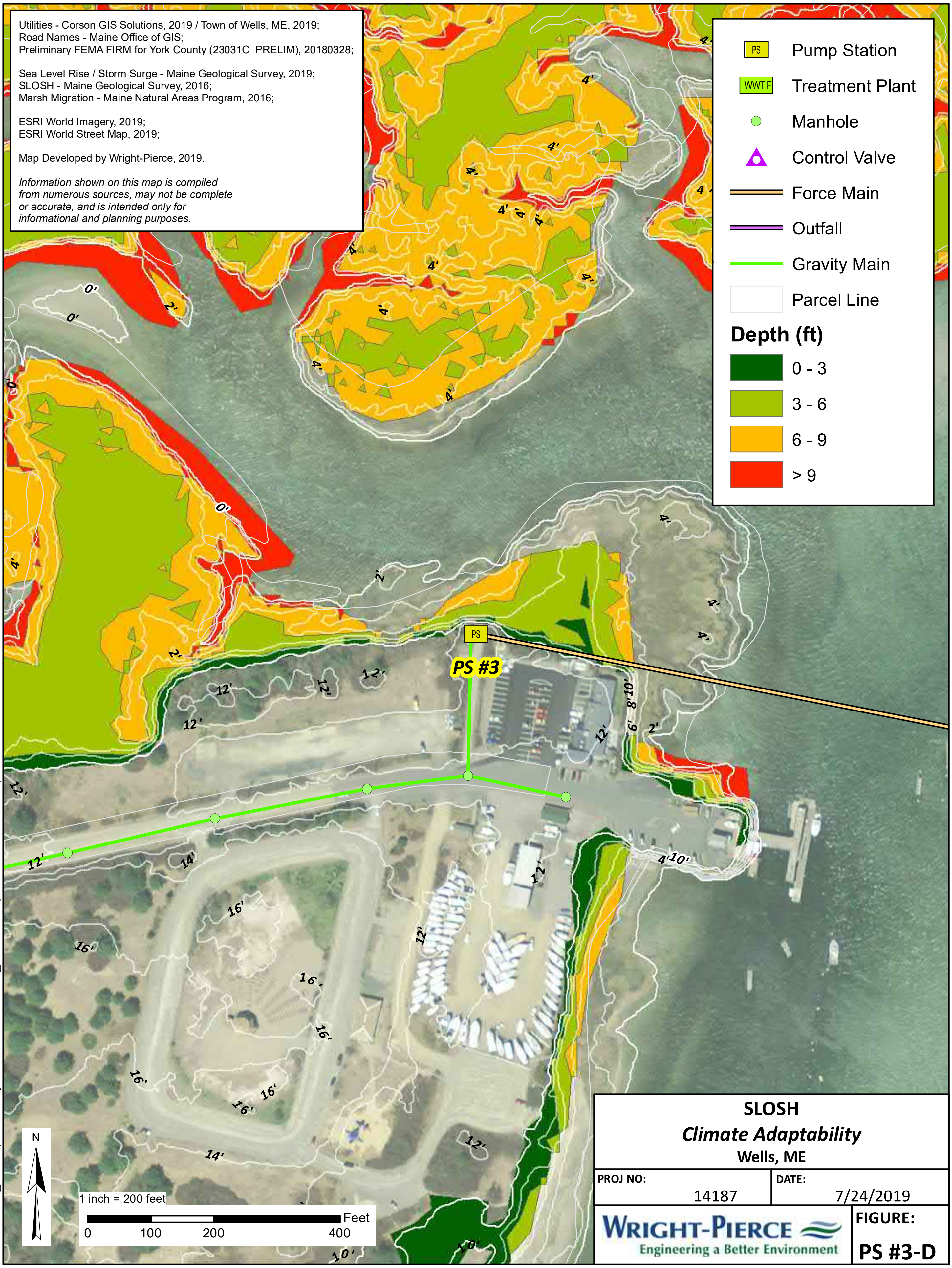

Utilities - Corson GIS Solutions, 2019 / Town of Wells, ME, 2019;
Road Names - Maine Office of GIS;
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Sea Level Rise / Storm Surge - Maine Geological Survey, 2019;
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SLOSH
Climate Adaptability
Wells, ME

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FIGURE:
PS #3-D

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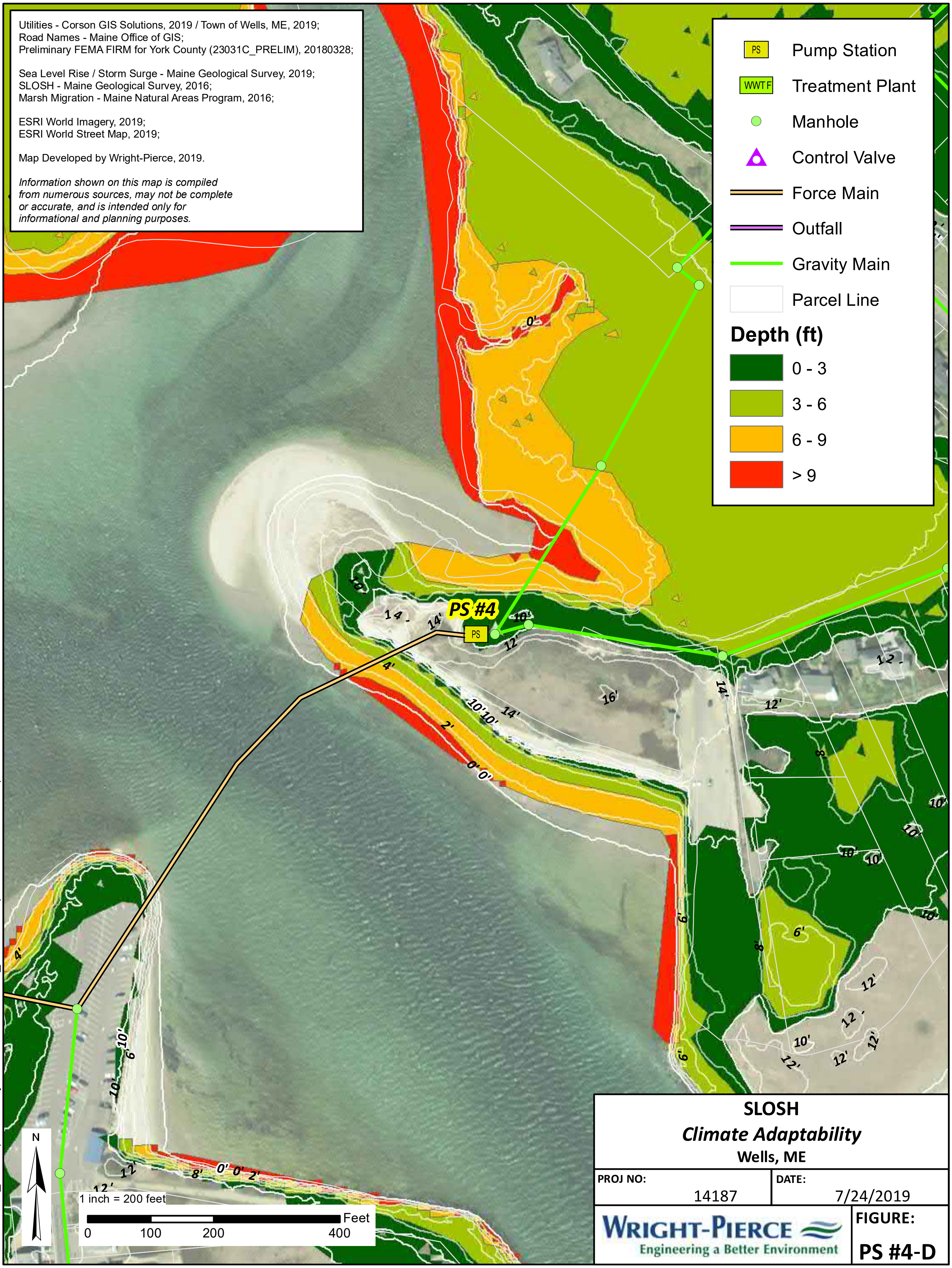

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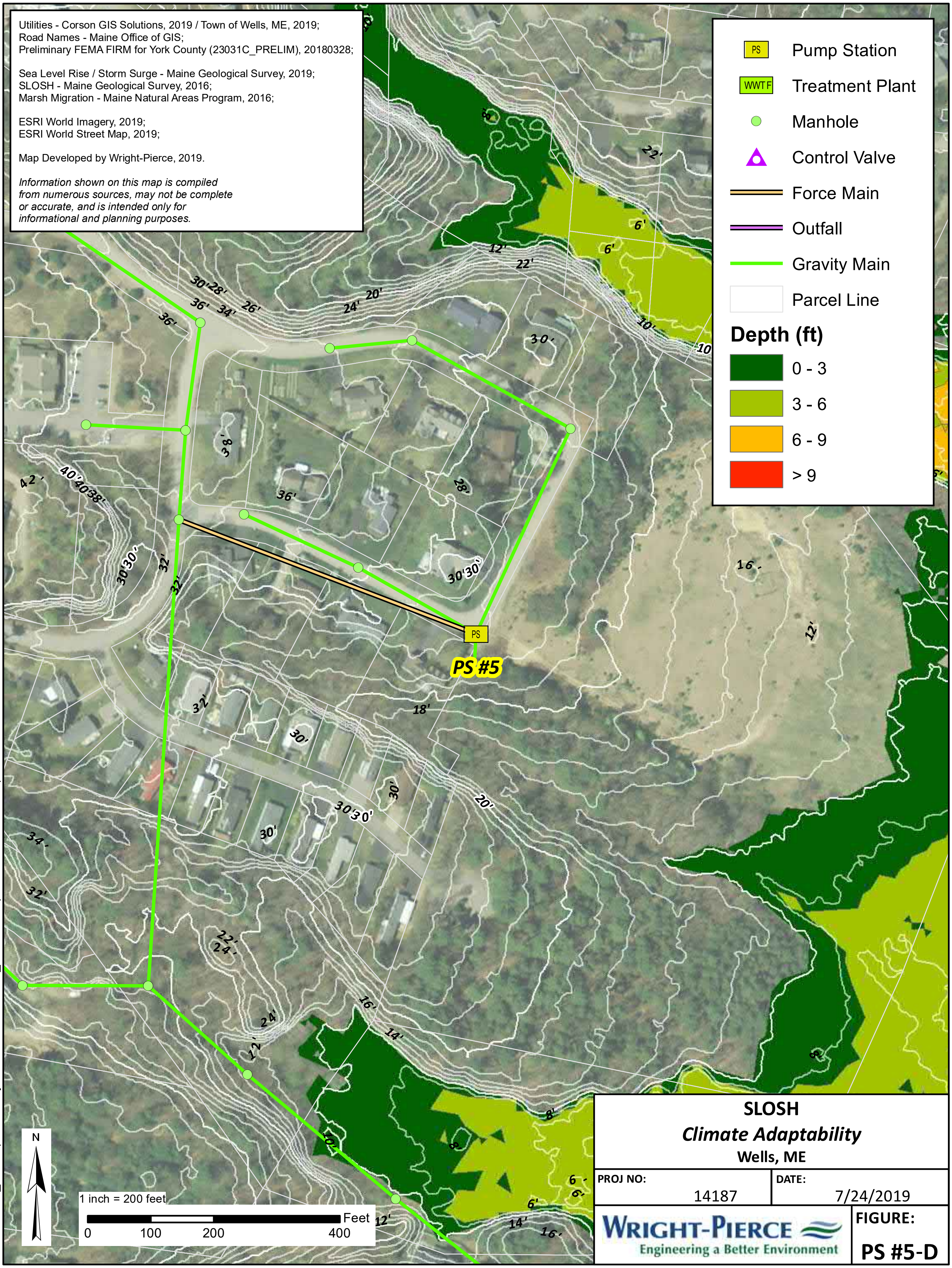

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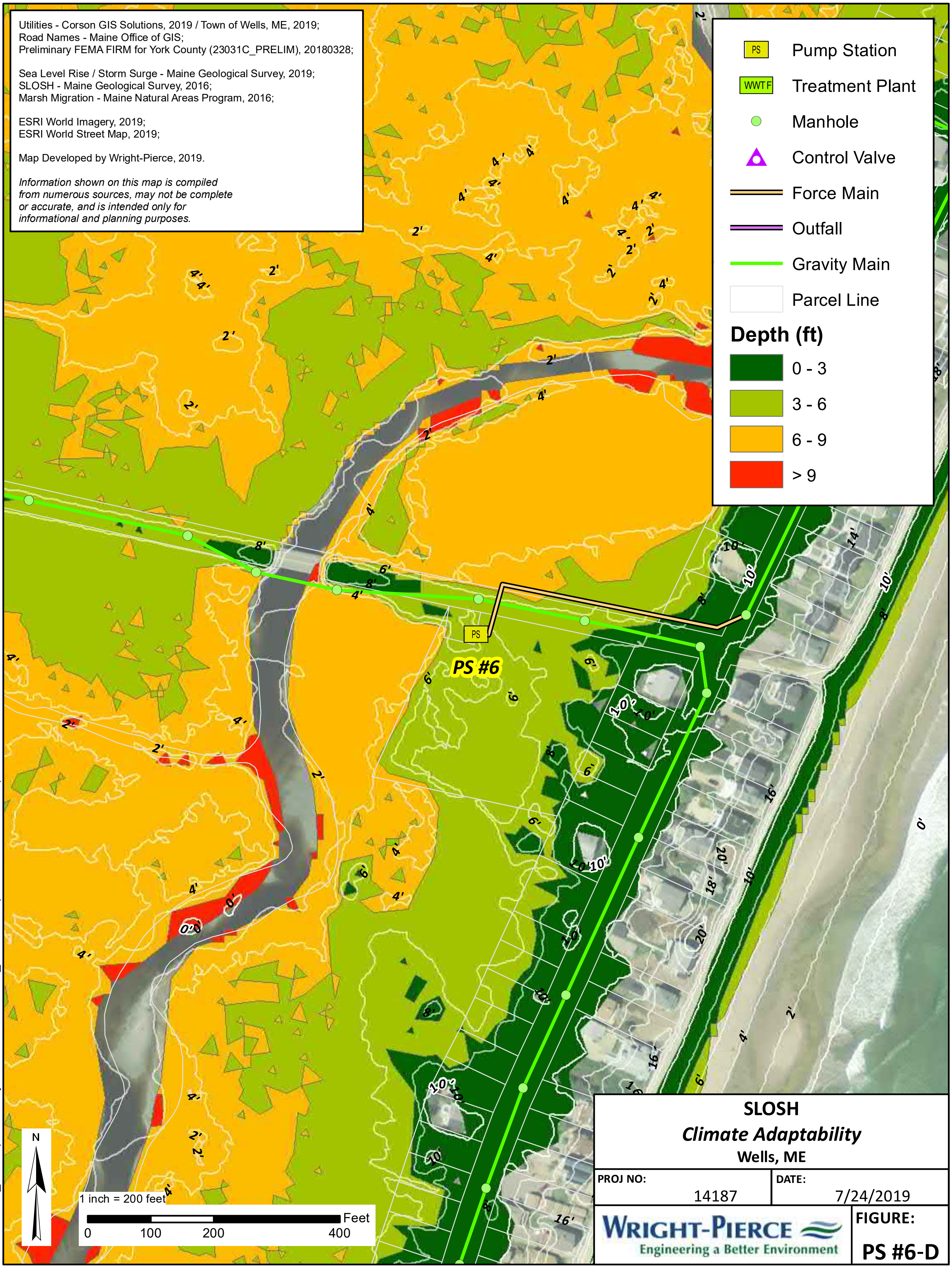

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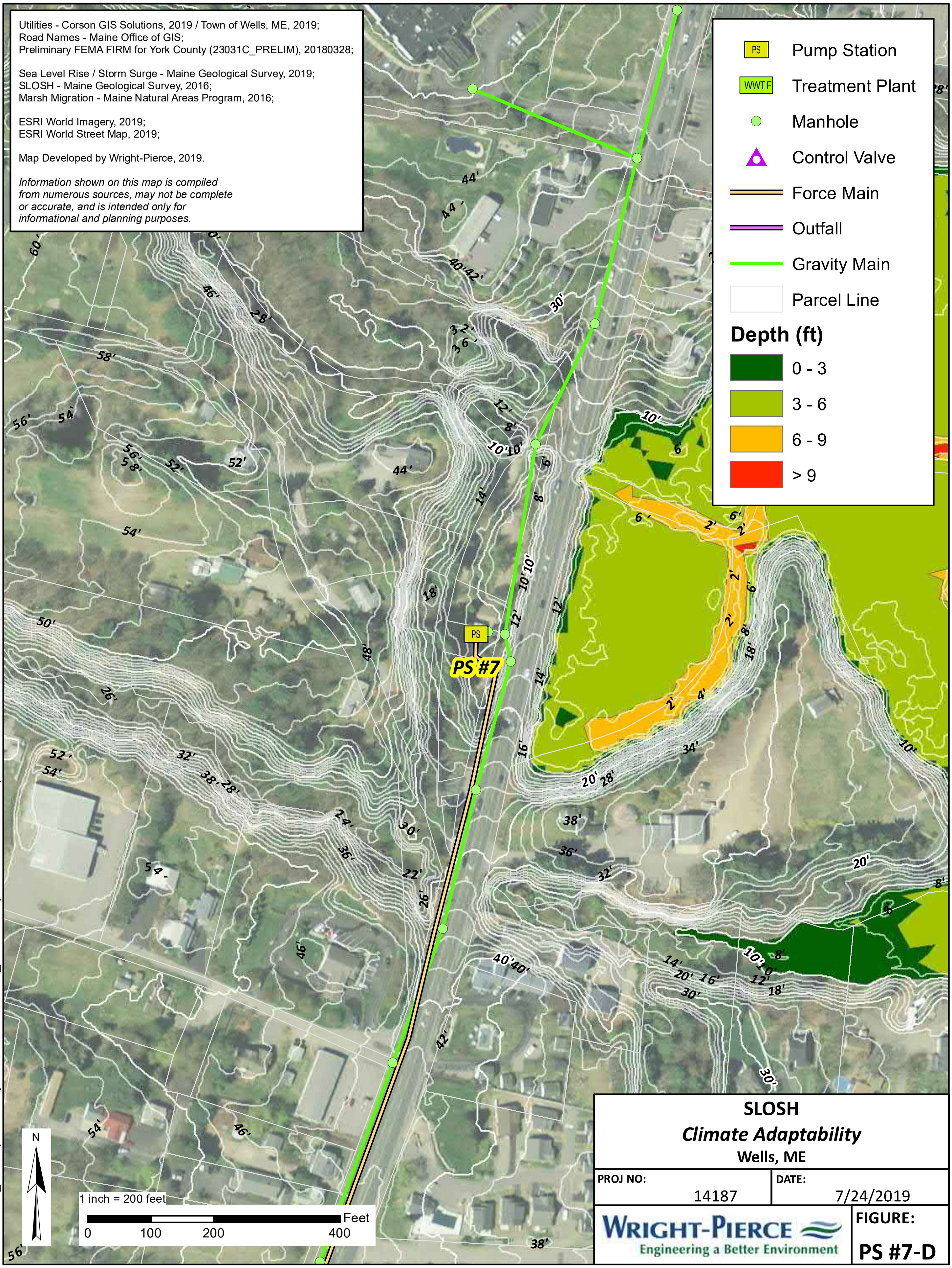

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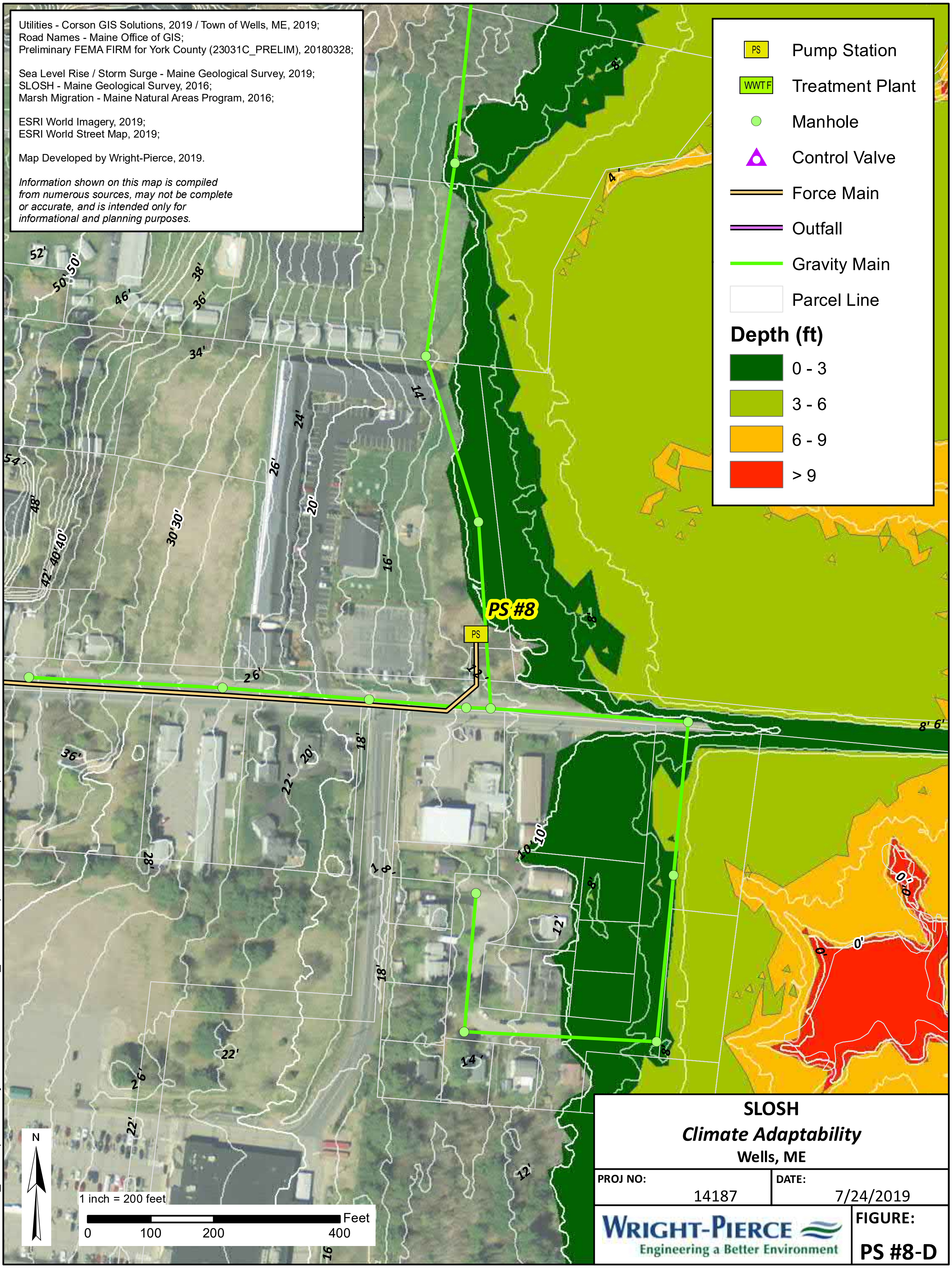

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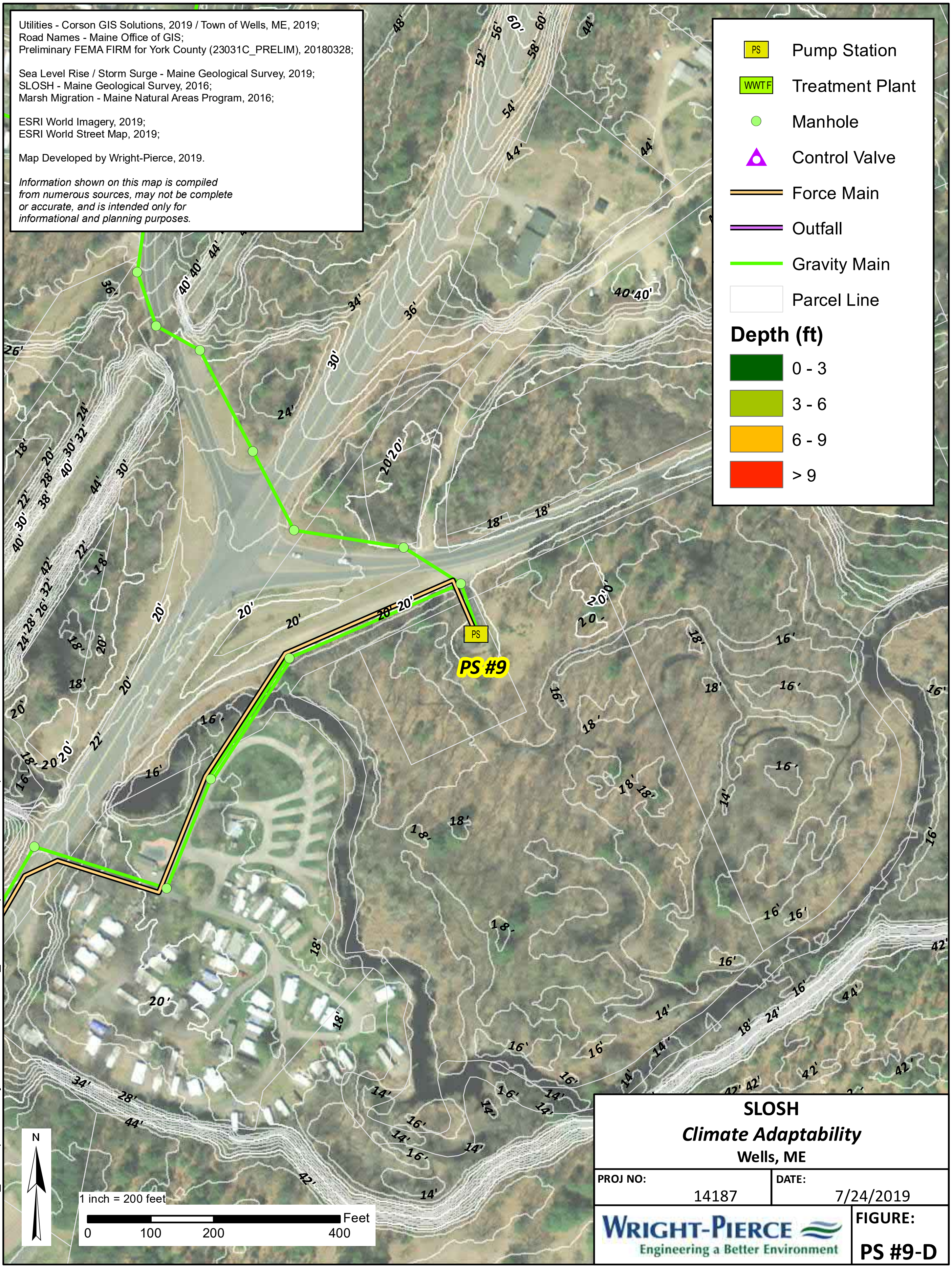

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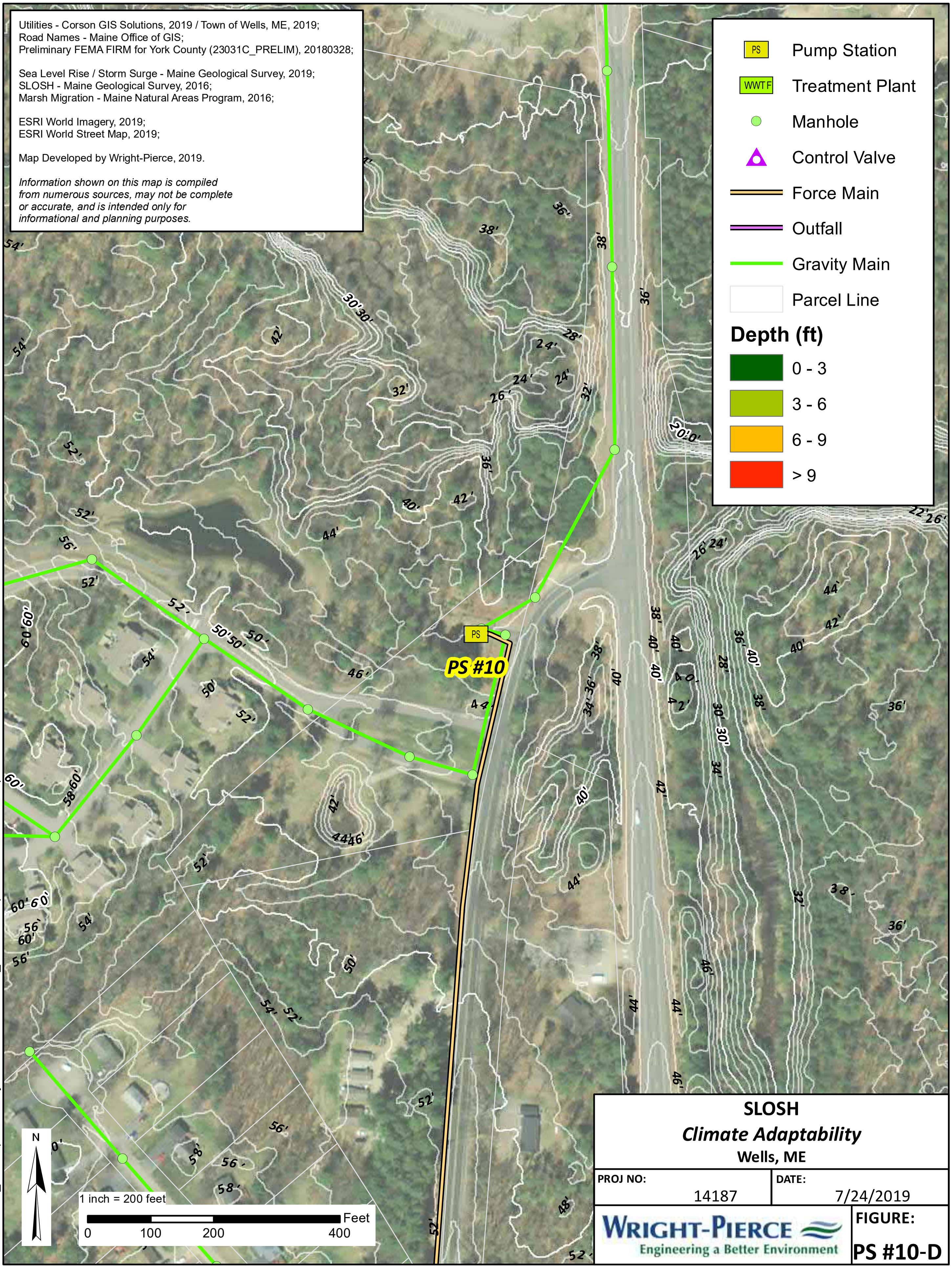

SLOSH
Climate Adaptability
Wells, ME

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FIGURE:
PS #10-D

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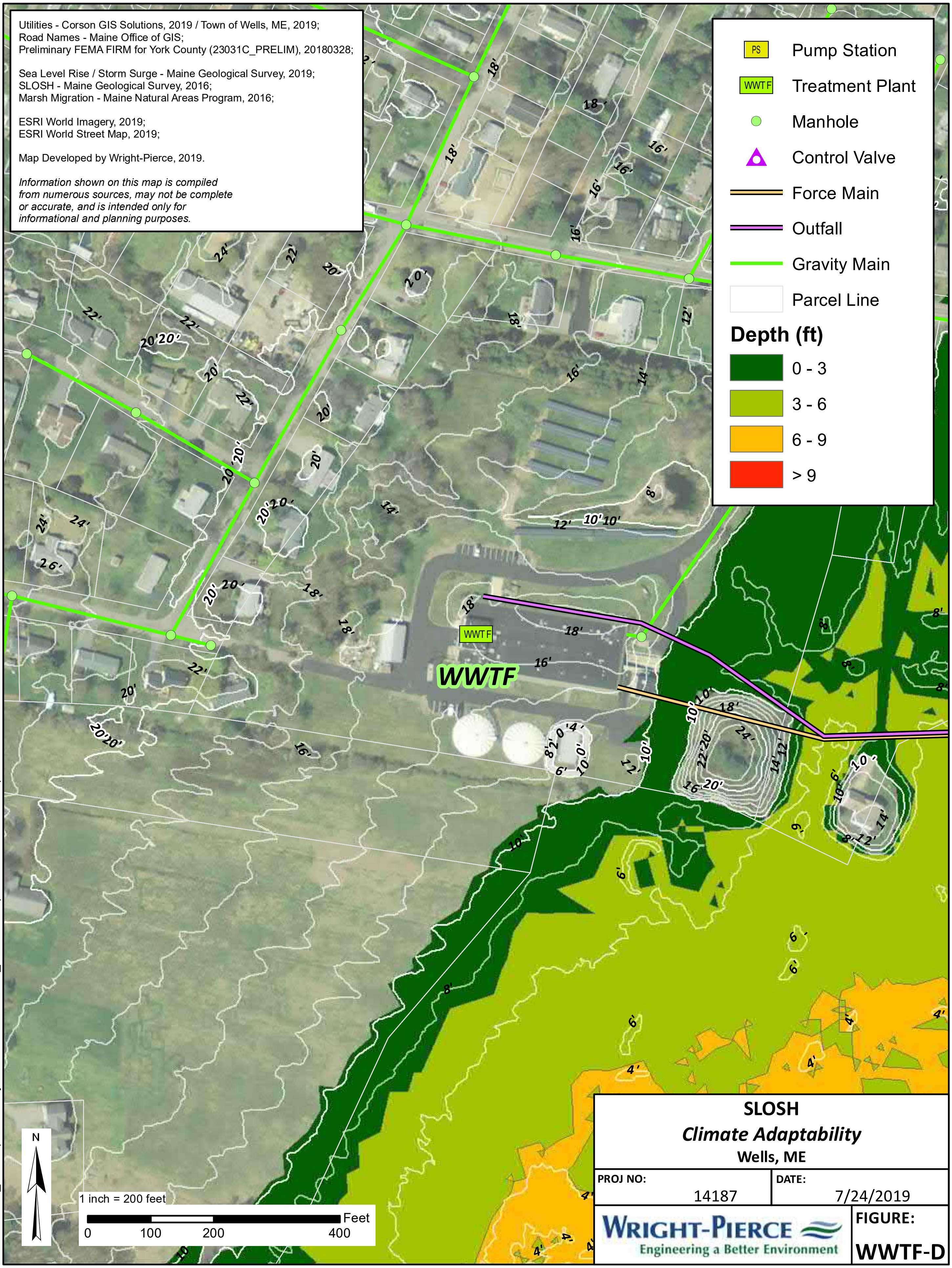

SLOSH
Climate Adaptability
Wells, ME

PROJ NO:	DATE:
14187	7/24/2019

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FIGURE: **WWTF-D**

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