HARFORD COUNTY DPW

LOWER BYNUM RUN

SMALL WATERSHED ASSESSMENT REPORT APPENDICES

DECEMBER 13, 2019




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HARFORD COUNTY DEPARTMENT OF PUBLIC WORKS

DATE: DECEMBER 2019

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APPENDIX A EXISTING BMP SUMMARIES

This appendix summarizes the BMP assessments that were conducted on the dry detention ponds and extended detention ponds in the Lower Bynum Run watershed. The following information was collected during the assessments. Some was not applicable to all of the sites and are not included in the site summaries.

- Verification of desktop/design plan drainage area
- Measurement of facility bottom width and length
- Descriptions of any maintenance needs
- Observations of accessibility for construction and maintenance access
- Identification of all inflow points into the facility and verification of the elevation change between the inflow inverts and the outflow structure invert for the facility.
- Evaluation of the condition of the inlets and outfall structure.
- Identification of standing water and/or wetland vegetation in the facility
- Identification of the facility's emergency spillway, if present
- Inspection of manholes near facility to verify storm drain network leading to facility

Existing HA14BMP000933 is located behind residences on the north end of Cogswell Court. There is unobstructed access from Cogswell Court to an 18-foot swing gate. It is within the MSB-2 subwatershed. It consists of a sediment forebay on the eastern part of the facility that conveys flows to a dry pond. The dry pond drains through a riser control structure and into a natural channel. A 24-foot grass emergency spillway exists on the northeast part of the facility. Flows from Cogswell Court are split before entering the facility at two inflow points. A 12-inch CMP pipe conveys flows into the forebay. There is wetland vegetation in the forebay, and it is in good condition. A 24-inch CMP conveys flows directly into the dry pond. The facility appears to be relatively new, and all structures are in excellent condition.

Figure A-1. Forebay from access gate (left); 24-inch CMP inflow point and riser structure from access gate (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There was 0.02 inch of rainfall in the area on the two days prior to the site visit. A concrete riser structure sits on the northern border of the facility. Flows enters through a 6-inch PVC low flow orifice with trash rack and discharges through a 30-inch CMP principal spillway. The outfall is in excellent condition. The outfall channel is in good condition up until 50 feet upstream of confluence with a natural channel. There is a 4-foot headcut and minor erosion at this point in the channel.

Figure A-2. Facing upstream at outfall and outfall protection (left); Facing upstream at headcut and erosion in outfall channel (right)

Existing HA15BMP000094 is located off Kenna Court, surrounded by townhouses including 2500 Kenna Court. The facility is accessible from the road and has an 18-foot swing fence. It is within the MSB-4 subwatershed. The facility consists of a dry pond and sand filter that discharge to the storm sewer system. Incoming flows originate from the sand filter at the eastern end of the site and from the inlet located in the western portion of the site. There was no shallow standing water or wetland vegetation observed within the facility.

There was 0.1 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall recorded in the area on the two days prior to the site visit. Low flow enters through a 12-inch HDPE pipe with an orifice plate constricting the flow diameter to 1.5 inches. The low-flow orifice is housed in a riser structure consisting of triangular prism trash rack. Flows discharge out the riser from a 24-inch RCP principal spillway and enter the municipal storm sewer system.

Figure A-3. Facing southwest towards facility at inflow pipe (left); facing west towards sand filter (right)

Existing SWM000029 is located off St. Mary's Church Road on the side of New Covenant Presbyterian Church. It is accessible from the road and has an 18-foot swing gate. The facility is within the MSB-4 subwatershed. It consists of a dry pond that is routed through a riser and drains to the storm sewer system. A 24-inch corrugated HDPE pipe conveys flow from a northern parking lot into a wetland on the eastern side of the facility. A 6-inch PVC riser conveys flow from the eastern wetland area to the main dry pond in the center of the facility. Flows from the roof, field, and playground areas are conveyed into the facility and the inflow is protected by riprap. A French drain at the base of the western parking lot collects runoff and conveys it via a 12-inch CMP into the facility's western wetland area. Water in the wetland covers the 12-inch CMP, its 6-inch PVC control structure, and is nearly overflowing its eastern berm. There are lily pads and cattails in the wetland, and trees on the edges have been partially submerged. The submerged 6-inch PVC control structure conveys flow into the dry pond. A 14-foot wide grass emergency spillway exists on the east part of the southern border of the facility.

Figure A-4. Facing west at the dry pond and wetland area from the inflow point (left); Eastern wetland region of the facility (right)

There was no rainfall observed in the area on the day of the site visit (5/29/19). There were 0.09 inch of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits just outside the western wetland in the facility. Low flow enters through a 6-inch PVC pipe. Flow is discharged from the facility through a 12-inch CMP principal spillway and immediately enters a 24-inch CMP at the outfall. Both the outfall and 24-inch CMP end sections have major rust damage. Riprap protection in good condition surrounds the outfall. Flow enters the 24-inch CMP, flows under St. Mary's Church Road, and

enters the storm sewer system. An individual inside the church indicated that recent work on the BMP had been completed in the summer of 2018. Expenses to the church exceeded $30,000.

Figure A-5. Facing south, towards St. Mary's Church Road, at the riser (left); Outfall (right)

Existing SWM000039 is located behind residences off Bigmount Court. Access is difficult due to steep slopes and is only accessible from private property. The facility is within the MSB-4 subwatershed. The facility consists of a dry pond that drains through a riser to a channel. An 18-inch CMP discharges flows from residences on Bigmount Court into the northeast part of the facility. Flows enter a 5-foot wide riprap channel which conveys runoff to the riser. Another 18-inch CMP conveys flows from residences on Smallwood Drive into the southeast part of the facility. A riprap channel directly behind this CMP pipe acts as the third inflow point. There is minor riprap displacement around the southeast inflow points.

Figure A-6. Facing west towards facility at inflow pipe (left); Facing east toward facility at inflow channel (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02 inch of rainfall in the area on the two days prior to the site visit. A 38-inch diameter cylindrical CMP riser structure sits in the center of the northern border. Flows enter through a 5-inch CMP low flow orifice and discharge through an 18-inch CMP principal spillway. There is minor riprap displacement at the outfall. There is minor channel erosion extending up to approximately 100 feet downstream from the outfall.

Figure A-7. Riser structure and embankment (left); Facing downstream towards outfall protection and outfall channel (right)

Existing SWM000040 is located south of residences off of Lindsay Court. There is very good access from the remnants of a construction access path west of the facility. The facility consists of a dry pond that drains through a riser control structure and into a channel. It is within the MSB-4 subwatershed. An 18-foot riprap emergency spillway sits in the southwest corner of the facility. The facility has four inflow points. A 30-inch CMP conveys flows from residences along Smallwood Drive and Boeing Court into the eastern part of the facility. Flows travel in a riprap channel to the riser structure. A silt fence runs along the south bank of this channel. A riprap channel acts as another inflow point in this area. It conveys flows from residences into the east part of the facility. A 24-inch CMP conveys flows from residences along Colpepper Road and Lindsay Court into the center of the facility. The fourth inflow point is a riprap channel entering the west part of the facility.

Figure A-8. 24-inch inflow pipe and riser structure (left); Facing north towards riser structure, breached embankment, and stabilizing matting (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02 inch of rainfall in the area on the two days prior to the site visit. A 57-inch diameter cylindrical CMP riser structure sits on the southern border of the facility. Flows enter through a 6-inch CMP low flow orifice and discharge out an 18-inch CMP principal spillway. There is a failed super silt fence a few feet east of the riser. The embankment behind the riser has been completely eroded; stabilizing matting and silt fences are failing. Dry mud is visible on the top of the riser structure. There is substantial debris in the outfall channel.

Figure A-9. Outfall and outfall protection (left); Facing upstream at outfall and outfall protection (right)

Existing SWM000041 is located off West Rhododendron Drive, behind residences including 2608 W. Rhododendron Drive. It is accessible from the roadway and has an 18-foot swing gate. A portion of the fence behind the riser was removed when the field team visited the site. The facility is in the MSB-4 subwatershed. It consists of a partial wet pond that is routed through a riser control structure and drains to a channel. A 32-inch RCP with concrete end section conveys flows from W. Rhododendron Drive into an 8-foot wide by 13-foot long plunge pool on the eastern part of the facility. The seal connecting the end section to the rest of the pipe is broken and there is major erosion surrounding the pipe at this damaged area. Another inflow is located at the southeastern tip of the facility. Flows from residences naturally enter the facility and flow down an 8-foot wide by 42-foot long riprap slope. A 36-inch RCP with end section conveys flows into the facility's southern tip. There are numerous animal burrows and major erosion around the inflow. There is minor riprap displacement and minor erosion along the route the flows take from the inflow to the wet pond. The western part of the facility is covered with wet soil. Numerous 4-inch residential HDPE pipes were observed by the field team conveying flow into this area. They contribute a negligible amount of flow to the western part of the facility. An inflow exists on the western tip of the facility conveying flows onto a 16-foot wide by 71-foot long riprap slope. A 26-foot grass emergency spillway exists on the northern border of the western part of the facility.

Figure A-10. Facing west towards riser, embankment, and broken fence (left); Facing south towards erosion behind the 36-inch RCP inflow pipe (right)

There was no rainfall observed in the area on the day of the site visit (5/29/19). There were 0.09 inch of rainfall in the area on the two days prior to the site visit. A concrete riser structure exists in the eastern

half of the facility. There are a few animal burrows and minor erosion around the riser structure. Low flow enters through a 4-inch PVC pipe. The low flow pipe sits 2 feet above the pond bottom. The low flow pipe is broken 27 feet from the riser. Flows discharge out the riser from a 36-inch CMP principal spillway. A 20-foot wide by 34-foot long riprap protection exists at the outfall where flows enter an unnamed tributary to Bynum Run. The immediate outfall area extending to 100 feet downstream has minor erosion. Flows pass under W. Rhododendron Drive about 200 feet downstream of the outfall via a 90-inch CMP.

Figure A-11. Facing east toward facility at 36-inch RCP inflow pipe (left); Outfall and outfall protection (right)

Existing SWM000058 is located at the southern end of Balmoral Drive, behind residences including 1 McGregor Way. It is within the MSB-5 subwatershed. The facility consists of a dry pond that drains into a riser control structure and discharges to a natural channel. Flow enters the facility from the east via a CMP orifice that drains into a forebay. The CMP was buried under water and sediment. A natural channel conveys flows from the south into the pond. The dry pond has major sediment build up but appears to still function.

Figure A-12. Eastern CMP inflow point and forebay (left); The channel that conveys flow to the pond (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There were 1.45 inches of rainfall in the area on the two days prior to the site visit. A 7.5-foot diameter cylindrical CMP riser with vortex cover sits on the northern part of the facility. Low flows are designed to enter the riser through a

12-inch CMP dewatering device with trash rack. The pipe is buried under 3 feet of sediment and the trash rack was not located. Erosion has formed a 3-foot deep hole behind the riser. Flows discharge out of a 42-inch CMP principal spillway and into an unnamed tributary to Bynum Run. Downstream of the outfall there is moderate erosion (1 to 3 feet cuts) of the natural channel. The overall condition of the channel extending to approximately 100 feet downstream is good.

Figure A-13. Facing south towards facility and riser (left); Facing downstream at the outfall channel (right)

Existing SWM000084 is located west of Eastbend Court, behind residences including 3231 Eastbend Court. It is accessible from the road and is within the MSB-3 subwatershed. The facility consists of a dry pond and two natural streams that are routed through a riser control structure that drains to a natural channel. A 24-inch RCP with concrete end section conveys flows from residences to riprap on the northern part of the facility. Flows enter a forebay pretreatment pond. The pond has wetland vegetation and a 9-inch PVC control structure with mesh wrap. The two streams that feed into the dry pond have low flow rates. There is heavy wetland vegetation in the dry pond and the embankments surrounding the facility are covered with young trees (less than 10 years old).

Figure A-14. Facing east towards the 24-inch RCP inflow pipe (left); The embankment between the forebay and the riser control structure (right)

There was no rainfall observed in the area on the day of the site visit (5/29/19). There were 0.09 inch of rainfall in the area on the two days prior to the site visit. A 11.5-foot diameter cylindrical CMP riser sits on the eastern part of the facility. Flows enter through an 18-inch CMP orifice and discharge through a

48-inch CMP principal spillway with end section. High flows are conveyed over a circular weir inside the riser. A 31-foot wide by 26-foot long riprap outlet protection exists at the outfall where flows enter an unnamed tributary of Bynum Run. Flows undercut a gabion structure 30 feet from the outfall, and geotextile is visible. There is major erosion in the outfall area and extends hundreds of feet downstream.

Figure A-15. Facing west towards the facility from Eastbend Court (left); Facing upstream towards the undercut gabion structure (right)

Existing SWM000085 is located off of Birch Brook Lane adjacent to the property located at 3120 Birch Brook Lane. It is accessible via a chain link swing gate located along the southeast edge of the facility. The facility is within the MSB-3 subwatershed. One 28-inch RCP into the facility conveys flows originating from the storm sewer system to the southwest. One 20-inch RCP into the facility conveys flows originating from the storm sewer system to the northeast. The facility is in-line with an existing stream that enters the site from the northwest. A concrete riser structure controls flows out of the facility and discharges through a 54-inch CMP principal spillway. The principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the south. Shallow standing water and wetland vegetation were observed within the facility.

Figure A-16. Channel protection for the 28-inch RCP inflow point at western part of the facility (left); View of facility from access gate (right)

Rainfall totaling 0.05 inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on field observation, an 18-inch CMP conveys flows into the riser via a low-flow orifice. The size of the orifice could not be confirmed because the upstream end could not be located due

to heavy sediment buildup upstream of the riser. Overflow is conveyed through the inner lip of the 9-foot diameter circular CMP riser.

Figure A-17. Riser control structure and embankment (left); Outfall channel from Birch Brook Lane (right)

Existing SWM000089 is located off of Federal Lane adjacent to properties located at 1423 Crystal Ridge Court and 3717 Federal Lane. It is accessible from Federal Lane although a guardrail currently is present along the northern edge of the site. The facility is within the MSB-2 subwatershed. One 24-inch CMP into the facility conveys flows originating from the storm sewer system to the southwest. The facility is in-line with an existing stream that enters the site from the southeast. A concrete riser structure controls flows out of the facility and discharges through a 27-inch CMP principal spillway transitioning to a 42-inch CMP upstream of the outfall. The principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the north. Shallow standing water and wetland vegetation were observed within the facility.

Figure A-18. Facing south towards the facility from the 24-inch CMP inflow point (left); Facing upstream towards the channel that flows into the facility (right)

Rainfall totaling 0.05 inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observation), an 8-inch CMP conveys flows into the riser via a low-flow orifice. Overflow is conveyed through the 8-foot diameter circular CMP riser.

Figure A-19. Riser structure (left); Facing upstream towards the outfall channel and embankment (right)

Existing SWM000118 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000123(1) is located across from the APGFCU credit union building, 2113 Laurel Bush Road. It is accessible from Laurel Bush Road. The facility is within the MSB-4 subwatershed. One 42-inch RCP with a concrete end section conveys flows into the facility from the storm sewer system to the northwest. One 24-inch RCP with concrete end section conveys flows into the facility from the storm sewer system to the northeast. There is also a riprap ditch in the southwest corner of the site conveying flows from a natural channel to the southwest. The riprap ditch has mild to moderate erosion and riprap displacement. A CMP riser structure controls flows out of the facility and discharges through a 66-inch CMP principal spillway. A gabion reinforced plunge pool at the outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the east. Dense vegetation and saturated soils were observed within the facility.

Figure A-20. The 42-inch RCP inflow pipe and plunge pool (left); Riser control structure and low flow orifice (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field work), a low-flow 24-inch CMP is installed at the pond bottom. Overflows enter the 84-inch diameter corrugated metal riser structure and are conveyed through a 66-inch CMP principal spillway. The immediate outfall area is in good condition; however, there is some debris jamming approximately 30

feet downstream of the spillway where a gabion basket structure is creating a 2-foot to 3-foot elevation drop.

Figure A-21. Facing downstream at the outfall channel and debris jam (left); The 2 foot to 3 foot elevation drop in outfall channel after gabion basket structure (right)

Existing SWM000124 was field investigated on 5/16/19, but no existing facility could be located. There is a facility located approximately 0.4 miles northeast in the vicinity of 201 Royal Oak Drive (SWM000312) which matches the as-built (Bright Oaks Courtyard).

Figure A-22. Supposed location of SWM000124

Existing SWM000125 is located at the intersection between Hookers Mill Road and Bynum Overlook Drive. It has no fence surrounding it and is well maintained. There is good access to the facility from the roadway. The facility is within the MSB-3 subwatershed. The facility consists of an infiltration basin that drains to a natural channel. The basin collects flows from residences on Bynum Overlook Drive. Flows enter the northeast part of the facility through a 36-inch RCP and into a riprap forebay. The inflow needs currently bypasses the infiltration basin. A 32-foot riprap emergency spillway exists on the eastern part of the facility. Two 8-inch PVC dewatering devices, spaced on the southern border of the basin, drain flows to Bynum Run confluent to James Run. The outfall is in good condition, and there is minor erosion where the outflow enters the natural channel extending to approximately 100 feet downstream of the outfall.

Figure A-23. Facing northwest, adjacent to Hookers Mill Road, at the facility (left); Channel protection of the 36-inch RCP inflow that bypasses the facility (right)

There was 0.47 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit.

Figure A-24. Facing southeast toward facility (left); Channel downstream of the facility (right)

Existing SWM000126 is located off Deer Court, in between 911 Deer Court and 913 Deer Court. Access from the roadway is difficult due to steep embankments and heavy vegetation. The facility is within the MSB-3 subwatershed. It consists of a dry pond that collects flows from two pipes and a natural stream. The pond drains through a triple culvert that runs under Deer Court and returns flow into a natural stream. The stream providing inflows to the facility is in fair condition. It brings flows from the north to the facility and only has minor erosion. A 24-inch RCP conveys flows from residences from the east into a forebay on the east side of the facility. Another 24-inch RCP conveys flows from residences from the west into a forebay on the west side of the facility. In between these two inflows sits the triple culvert. There is standing water upstream of the culvert.

Figure A-25. Natural stream upstream of the facility (left); Forebay (right)

The triple culvert consists of two 48-inch RCPs and a 24-inch CMP that sits a little below and in between them. The 24-inch CMP's inlet is buried under sediment. The outfall has minor riprap displacement and sediment build up is impacting the 24-inch CMP. The western RCP at the outfall did not have flowing water, but the eastern RCP did. Flows drain into an unnamed tributary to Bynum Run. The immediate outfall area extending to approximately 100 feet downstream is in fair condition.

There was 0.47 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit.

Figure A-26. Upstream end of the triple culvert (left); Downstream end of the triple culvert (right)

Existing SWM000163 is surrounded by residences and is adjacent to 1407 Fountain Glen Drive. It is accessible from the roadway, but vegetation is overgrown in the pond. The facility is within the MSB-6 subwatershed. It consists of two pipe inflows and a stream inflow that convey flows to a dry pond. The pond drains through a riser control structure and back into a natural channel. A 24-inch RCP conveys flows from residences from the southeast into a forebay on the northern part of the facility. The pipe is half-full of sediment. Another 24-inch RCP conveys flows from residences from the northwest into a forebay on the northern part of the facility. A small berm separates the northern part of the facility from the pond in the southern part. A natural channel conveys flows from the north. The stream is by-passing the facility, leaving little flow for the facility to treat. A portion of the roadway acts as an emergency spillway.

Figure A-27. Stream that bypasses the facility (left); Riser structure (right)

There was no rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit. A non-traditional, concrete riser sits at the southwestern tip of the facility. Flows enter the riser through a 36-inch RCP orifice and discharge through an 8-foot RCP principal spillway. A plunge pool exists at the outfall where flows enter an unnamed tributary to Bynum Run. The riprap/gabion section of the outfall is in good condition, and downstream of the outfall only has minor erosion.

Figure A-28. Downstream view of outfall (left); Upstream view of outfall (right)

Existing SWM000166 could not be located during field investigations. GIS information indicates it is located along Foxborough Drive west of Bennett Place. The Foxborough Farms Section 3 Phase 2 record drawing calls out a structure in this vicinity called Stone Outlet Trap #2. The outfall channel adjacent to Bennett Place is eroded with the majority of the riprap displaced. The outfall's location is within the MSB-5 subwatershed.

Figure A-29. Record drawings of the site (left); Satellite imagery of the site (right)

Figure A-30. Facing downstream at the outfall channel (left); Outfall protection (right)

Existing SWM000198 is located behind residences on the west end of Royal Troon Court. There is unobstructed access from private properties around the facility. It is within the MSB-5 subwatershed. The facility consists of a dry pond that drains through a riser control structure to a natural channel. A 24-inch CMP conveys flows from residences on Royal Troon Court into the southern part of the facility. The pipe is half buried by sediment; there is a 24-inch headcut downstream out the inflow point. A 36-inch RCP conveys flows from residences on Muirfield Close into the northern part of the facility. A natural stream flows from east to west into the facility. A 48-foot grass emergency spillway exists on the southwest end of the facility.

Figure A-31. Facing downstream from the 36-inch RCP inflow pipe (left); Facing downstream towards the 24-inch CMP inflow channel (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02 inch of rainfall in the area on the two days prior to the site visit. A concrete riser structure sits on the northwest border of the facility. Flows enter through an 18-inch CMP. There is debris and sediment buildup at the pipe. Flows discharge through a 36-inch CMP principal spillway, enter an ex-SD manhole, and outfall through a 48-inch CMP. There is minor outfall sediment and outfall erosion. The channel extending 100 feet downstream is in good condition.

Figure A-32. Embankment and riser structure (left); Facing downstream at outfall (right)

Existing SWM000199 is located on East Ring Factory Road adjacent to 418 Sunny View Rd. The facility is within the MSB-6 subwatershed. One 30-inch corrugated metal pipe with a concrete headwall conveys flow from the east side of East Ring Factory Road and from a conveyance system running along East Ring Factory Road from the south. The outfall is partially enclosed by a wooden privacy fence that forms a square perimeter around the concrete headwall. The downstream wall has become damaged and misaligned due to channel flows. Gabion material and exposed geotextile were observed in portions of the channel immediately downstream of the outfall. The site is classified as a dry retention pond. The location discharges to an 8-foot width riprap lined channel that drains to an unnamed tributary to Bynum Run, crossing under East Ring Factory Road through a 97-inch by 154-inch arch RCP.

Figure A-33. Facing east towards outfall and wooden privacy fence (left); Damaged part of the fence downstream of the outfall (right)

Rainfall totaling 0.02 inch had been observed in the area two days prior to site visit. A puddle of standing water was observed at the outfall but the riprap channel was dry.

Figure A-34. Facing north downstream of the outfall channel (left); Facing south at the confluence of the outfall channel and an unnamed tributary to Bynum Run (right)

Existing SWM000203(1) is located behind the Seasons at Bel Air Apartments, 1001 Todd Road, near Royston Place. The facility is within the MSB-6 subwatershed. One 30-inch corrugated metal pipe with a concrete headwall conveys flow from a storm sewer system to the northwest. An additional 30-inch CMP with headwall conveys flows from the storm sewer system to the northwest. The inner pipe shows deterioration including rusting and loss of material. The facility discharges through a concrete riser structure with a 30-inch CMP principal spillway to a drainage channel discharging to Bynum Run to the southwest. The riser contains a low-flow orifice which was visibly flowing during the field visit. The facility is classified as a dry pond. Less than half a foot of standing water was observed within the facility.

Figure A-35. Facing northeast towards facility (left); Damaged 30-inch CMP inflow pipe (right)

Rainfall totaling 0.02 inch had been observed in the area two days prior to site visit.

Figure A-36. Riser structure and embankment behind it (left); Erosion from stream under facility's outer fence (right)

Existing SWM000204 and SWM000338 is located in the natural area bounded by Tredmore Road to the east, Todd Road to the south, Greenbrier Shopping Center to the west, and residences including 1313 through 1349 Artists Lane to the north. Records state that this area has two BMPs; however, field observation indicates it is one continuous facility. It is accessible from Todd Road. The riser structure is accessible via an 18-foot maintained access path along the upstream embankment, perpendicular to Todd Road. The facility is within the MSB-6 subwatershed. One 48-inch pipe into the facility conveys flows originating from the storm sewer system to the northeast. One 30-inch pipe into the facility conveys flows originating from the storm sewer system to the southeast. One 30-inch RCP into the facility conveys flows originating from the storm sewer system to the north. A concrete riser structure controls flows out of the facility and discharges through a 36-inch RCP principal spillway. The principal spillway drains to a channel discharging to Bynum Run to the west. Heavy vegetation was observed in the facility including approximately 75% small diameter tree cover and wetland vegetation.

Figure A-37. 30-inch RCP at northern end (left); Riser structure with overgrown plants (right)

No precipitation had been observed in the area on the day of the site visit (4/30/19). Rainfall totaling 0.02 inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observation), a 24-inch BCCMP conveys flows into the riser via a low-flow orifice. Overflow is conveyed through a 30-foot width emergency spillway north of the riser.

Figure A-38. Overgrown plants in facility (left); Emergency spillway (right)

Existing SWM000223 is adjacent to properties located at 1318 Hidden Stream Drive and 1302 Hidden Stream Drive. It is accessible from Hidden Stream Drive. Guardrails run along the width of the ROW on the upstream and downstream embankments. The facility is within the MSB-2 subwatershed. One 30-inch RCP into the facility conveys flows originating from the storm sewer system to the west. The site also receives inflow from a natural stream flowing from the southwest. A concrete riser structure controls flows out of the facility and discharges through a 78-inch BCCMP principal spillway. The

principal spillway drains to a channel discharging to Bynum Run to the northeast. Approximately 3 feet of accumulated silt was observed in the facility. The low flow pipe and headwall were not visible due to the material buildup.

Figure A-39. 30-inch RCP inflow pipe and forebay at northwest edge of facility (left); Facing south towards facility (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings, a 36-inch BCCMP with concrete headwall conveys flows into the riser via a low-flow orifice. There is no emergency spillway.

Figure A-40. Slope between the riser structure and Hidden Stream Drive (left); Slope from Hidden Stream Drive down to the outfall (right)

Existing SWM000229 is located off Hunters Run Drive, adjacent to residences including 400 Hunters Run Drive. It is accessible from the road, but the slopes off the road are moderately steep. The facility is within the MSB-4 subwatershed. It consists of twin water quality treatment beds that convey flow into two separate natural streams. The two streams then converge onto a spillway. All flow is collected at the spillway and conveyed to the outfall. A 24-inch CMP receives flow from the Saddle Run Community to the north and conveys it into the northern water quality treatment bed. There are 2 to 3 inches of standing water in the water quality bed and there is moderate sediment build up. The end section of the CMP is rusted and there is minor riprap displacement at the inflow point. A 15-inch RCP with 58-inch headwall also conveys flow into the northern water quality bed. The trash rack attached to the end of the pipe is loose. A 36-inch CMP receives flow from the Hunters Run Community to the south and conveys

it into the southern water quality treatment bed. There are 4 inches of standing water in the water quality bed and there is major sediment build up. There is major erosion at the point where the water quality bed discharges flow into its natural stream. There is minor riprap displacement at the inflow. Both streams are in good condition upstream of the facility.

Figure A-41. Erosion in natural stream near the outfall of the southern water quality treatment bed's overflow pipe (left); 15-inch RCP inflow pipe, the northern CMP inflow pipe, and the northern water quality treatment bed

There was no rainfall observed in the area on the day of the site visit (5/29/19). There was 0.09 inch of rainfall in the area on the two days prior to the site visit. There is no riser structure. A 36-inch RCP with 17-foot headwall serves as the principal spillway. There is moderate erosion behind the headwall. A log blocked part of the pipe, causing major sediment buildup in front of it. Flow is conveyed under Hunters Run Drive, which serves as the embankment (61 feet), to the outfall on the other side. At the outfall, flow enters a silted pool that is approximately 3 feet deep. The slopes that lead down to the outfall from the roadway are reinforced with riprap in good condition. A 6-inch PVC pipe and a 3-inch corrugated HDPE pipe convey flow into the riprap on the northern slope. There is minor erosion downstream of the outfall where the flow enters an unnamed tributary of Bynum Run. The overall condition downstream of the outfall is good.

Figure A-42. Facing south toward the facility (left); Outfall, silted pool, and the embankment behind the outfall (right)

Existing SWM000257 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000259 is located off Glenangus Drive behind residences including 1500 Parkland Drive. It is accessible from Glenangus Drive. The facility is within the MSB-5 subwatershed. The facility consists of an infiltration basin that drains to a natural channel that is routed through a riser control structure. The infiltration basin is separated from the downstream natural channel by a timber weir. A 30-foot length PVC pipe at the floor of the facility drains low flows around the weir wall. In its current condition the infiltration basin has several feet of standing water (up to the top of the wood weir) and wetland vegetation, indicating the PVC low flow orifice may be clogged. The PVC pipe was not visible during field inspection. There is severe slope erosion along a portion of the slope leading from the infiltration basin toward the stream. The inflow pipes into the infiltration basin include one 18-inch BCCMP conveying flows from two dual grate inlets along Glenangus Drive and one 24-inch RCP with a concrete end section conveying flows from the residential area to the east. Damaged silt fence is visible around the 24-inch RCP outfall.

Figure A-43. Infiltration basin from behind the RCP inflow pipe (left); Infiltration basin from behind the timber weir (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The concrete riser structure sits at the toe of the embankment of Glenangus Drive. Flows enter through a 24-inch RCCP pipe orifice and discharge through a 24-inch RCCP principal spillway. A plunge pool exists at the outfall where flows enter Bynum Run confluent to James Run to the southwest. Multiple fallen large diameter trees were observed upstream of the riser area. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-44. View of riser structure from Glenangus Drive (left); Facing southwest towards riser structure, fallen trees behind the infiltration basin (right)

Existing SWM000286 is located northeast of Towson Road, behind residences including 1008 Towson Road. The facility is accessible from private backyards, and the field team had to go around existing yard fences. A utility road exists behind the facility. It is located within the MSB-3 subwatershed. It consists of a dry pond that is routed through a riser control structure and drains to Bynum Run. A 24-inch CMP with headwall conveys flows from residences along Hamburg Drive into the northwest part of the facility. A riprap slope also conveys flows from 922 Hamburg Drive into the northwest part of the facility. A 24-inch CMP with headwall conveys flows from residences along Towson Road into the southeast part of the facility. A 5-foot scour hole and minor riprap displacement exists at this inflow.

Figure A-45. Facing north towards facility (left); Facing downstream at inflow scour hole (right)

There was 0.41 inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02 inch of rainfall in the area on the two days prior to the site visit. A 57-inch diameter cylindrical CMP riser structure sits on the northern border of the facility. Flows enter through an 8-inch CMP low flow orifice and discharge through a 24-inch principal spillway. There is minor sediment buildup in the principal spillway. The outfall and outfall protection is in fair condition. The outfall channel extending 100 feet downstream is in good condition.

Figure A-46. Facing downstream at outfall channel and Bynum Run (left); Facing south at embankment and access point behind residential yard fences (right)

Existing SWM000287 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000295 is encircled by Dunkeld Way and its residences. It is easily accessible from the road, well maintained, and does not have a fence. The facility is within the MSB-4 subwatershed. The facility consists of two infiltration basins that drain to an extended dry detention pond. The pond drains through a riser control structure and discharges to a natural channel. Two inflows convey flow into the southeast infiltration basin: a 24-inch RCP and an 18-inch RCP. Both have moderate sediment build up in front of their inflows. The bottom of the infiltration basin is sediment filled. This basin drains over a riprap spillway westward, towards the riser structure which sits at the southern part of the facility. Another inflow exists just north of this basin. A 21-inch RCP conveys flows onto a riprap plunge pool, but flows do not enter the infiltration basin right next to it. Instead, they travel to the pond at the center of the facility. Two inflows convey flow into the northeast infiltration basin: an 18-inch RCP and a 24-inch RCP. This infiltration basin has a 26-foot grass emergency spillway that conveys flow to the pond in the center of the facility. There are three more pipe inflows on the northern border of the facility. A double culvert reinforced with gabions conveys flows into the central pond. The culvert consists of a 36-inch RCP and a 5-foot by 3-foot elliptical RCP. The inflow is in good condition. The other inflow on the northern border (eighth total) is a 24-inch RCP with moderate sediment build up. It conveys flows to the central pond as well.

Figure A-47. Facing south towards southeast inflow pipes, the southeast infiltration basin, and the riser structure (left); Facing north towards the facility and the elliptical culvert inflow pipe (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There were 1.45 inches of rainfall in the area on the two days prior to the site visit. The concrete riser structure on the south end of the facility has weir openings on all sides. The riser is in good condition but has graffiti on the inside. Low flows from the pond enter the riser through an 18-inch RCP and discharge through a 60-inch RCP principal spillway. A riprap plunge pool exists at the outfall where flows enter an unnamed tributary to Bynum Run. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-48. View of riser structure from Glenangus Drive (left); Looking upstream to the outfall (right)

Existing SWM000312 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000332 is located off Hookers Mill Road, across the street from residences including 810 Eastridge Road. It is surrounded by a fence and has an 18-foot gate located behind the riser structure. The site has steep embankments that are well maintained. The facility is within the MSB-3 subwatershed.

It consists of a wet pond (1.5 feet deep) that drains through a riser control structure and into a natural channel. A 38.5-inch CMP inflow pipe conveys flows into the northwest part of the facility. A plunge pool exists at this inflow. The inflow is in good condition. A riprap channel on the southwest corner of the facility acts as the second inflow point. It conveys flows from the roadway into the facility.

Figure A-49. Facing northwest towards the 38.5-inch CMP inflow (left); Facing northeast towards riser structure, access gate, and east side of the facility (right)

There were 0.47 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the northern border of the facility. Flows enter through a 12-inch PVC pipe and discharge through a 48-inch RCP principal spillway. A plunge pool exists at the outfall and there is a steep 6-foot drop at the end of the riprap. Flows enter an unnamed tributary to Bynum Run. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-50. Access to facility from Hookers Mill Road (left); Embankment behind the riser structure and the outfall's riprap channel protection (right)

Existing SWM000333 is located directly east of Old Ridgeline Way, between 817 Oak Mill Court and 816 Bynum View Court. It is surrounded by a fence and has an easily accessible gate. The embankments are mowed and well maintained. The facility is within the MSB-3 subwatershed. It consists of a dry extended detention pond that drains through a riser control structure and into a natural channel. A 24-inch RCP conveys inflows from residences along Oak Mill Drive into a forebay on the northern part of the facility. A plunge pool in good condition exists at this inflow. Two more inflows exist at the southern end of the facility and convey flows into another forebay. A riprap channel conveys flows off Old Ridgeline Way and

an 18-inch RCP conveys flows from Bynum View Court into the forebay. There is minor vegetation in the riprap channel.

Figure A-51. Southern inflow points (left); View of facility from southern inflow points (right)

There were 0.47 inch of rainfall observed in the area on the day of the site visit (5/23/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the eastern border of the facility. Flows enter through a 12-inch PVC pipe dewatering device. Flows discharge out a 27-inch RCP principal spillway and into an 8.5-foot wide plunge pool. There is a 7-foot drop with moderate erosion at the end of the riprap and geotextile is visible. Flows enter Bynum Run confluent to James Run. The outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-52. Access path to facility from Old Ridge Way (left); Downstream at outfall channel (right)

Existing SWM000342 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000347 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000359 could not be located during field investigations. GIS information indicates it is located along Foxborough Drive west of Bennett Place. The as-built for this facility instead matches that for SWM000084. Its GIS location is in the MSB-3 subwatershed.

Figure A-53. GIS location of SWM000359

Existing SWM000363 is located off David Drive, adjacent to residences including 540 David Drive. It has an access road and no fence. The facility is within the MSB-5 subwatershed. It consists of an infiltration basin and two streams that convey flow to a dry pond. Flows from the pond are routed through a riser control structure and into a natural channel. The western stream has severe (greater than 5 to 6-foot) bank erosion upstream, while the eastern stream has moderate (greater than 3-foot) erosion along its channel. There is a 3-foot cut in the channel at the point where the streams converge before the pond. An RCP with an unspecified diameter conveys flows into the infiltration basin on the east part of the facility. There was standing water in the basin at the time of the site visit. High flows travel over a riprap weir and enter the pond.

Figure A-54. Facing east towards riser structure and infiltration basin (left)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There were 1.45 inches of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits at the southern border of the facility, next to David Drive. Flows enter the riser through an 18-inch vertical CMP with trash rack. There is a small chain link fence around the orifice. Sediment and sticks were covering the orifice. Flows discharge through a 66-inch CMP that conveys flows under David Drive and into an unnamed tributary to Bynum Run. Large amounts of sediment are transported downstream through the riser. The immediate outfall area extending to approximately 100 feet downstream is in good condition. Downstream channel past 100 feet has 2 to 3-foot cuts and 6 to 7-foot bank erosion.

Figure A-55. Slope from David Drive to riser structure (left); Slope from David Drive to outfall (right)

Existing SWM000393 is located adjacent to Old Emmorton Commons, 2225 Old Emmorton Road. It is accessible from Old Emmorton Road. The facility is within the MSB-4 subwatershed. One 36-inch HDPE with a metal end section conveys flows into the facility from the storm drain system to the southwest. One 36-inch HDPE with a metal end section and trash rack conveys flows out of the facility toward the storm sewer system to the southeast. The trash rack has become disconnected from the pipe opening. There is no riser control structure onsite. Based on record drawings, the facility appears to convey flows

to an underground storage facility located approximately 242 feet downstream. The storage facility then discharges to the storm sewer system.

Figure A-56. Facing northwest towards facility (left); Disconnected trash rack (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The facility had standing water and wetland vegetation.

Figure A-57. Facing east towards the facility (left); Facing west towards the facility (right)

Existing SWM000415 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000416 is located off of Tiffany Trail behind the properties located at 4007 and 4009 Andrew Court. It is accessible via an access path off Tiffany Trail leading to a chain link swing gate. The facility is within the MSB-3 subwatershed. One 24-inch RCP conveys flows into the forebay upstream of the main facility. One 12-inch RCP conveys flows directly into the pond. Flows in the 12-inch and 24-inch inflow pipes originate from the storm sewer system running along Tiffany Trail to the northeast. One riprap slope measuring approximately 30-foot wide conveys overland flows from the southwest. A concrete riser structure controls flows out of the facility and discharges through a 24-inch CMP principal spillway. A riprap plunge pool at the principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the north. Shallow standing water and wetland vegetation were observed within the facility.

Figure A-58. Facing west towards facility at access gate (left); 24-inch RCP with broken seal (right)

Rainfall totaling 0.05 inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field work), a low-flow 6-inch perforated PVC pipe is installed at the pond bottom. Flows exiting the 6-inch PVC pipe travel overland across riprap and through a trash rack along the base of the concrete riser structure to enter an 8-inch low flow orifice. Overflow is conveyed through trash racks along the front face and top of the riser

Figure A-59. Access path from Tiffany Trail (left); Embankment behind riser structure (right)

Existing SWM000428 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000453 is located east of the cul-de-sac at the south end of Sidehill Drive; the surrounding area is residential. It is accessible from a 12-foot wide access road and 18-foot swing gate that is between 925 Sidehill Drive and 927 Sidehill Drive. The facility is within the MSB-4 subwatershed. It consists of a dry pond that is routed through a riser structure and drains to a natural channel. A 24-inch RCP conveys flow from Sidehill Drive to the western part of the facility. The seal six feet from the end section of the pipe is deteriorating. A 15-foot wide by 19-foot long plunge pool exists at the inflow. A 4-inch HDPE pipe conveys flow to the northwestern part of the facility. The HDPE pipe has no end section and is located at the top of the embankment. Flow is conveyed onto sloped riprap. A 24-inch RCP conveys flow into the northwestern part of the facility as well. It conveys flow from South Hill Court and discharges into a 12-

foot wide by 15-foot long plunge pool at the bottom of the facility. There is standing water in the plunge pool.

Figure A-60. Facility from northeast corner (left); Facility from southern corner (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). There was no rainfall observed in the area on the two days prior to the site visit either. The concrete riser structure is on the eastern side of the facility. Low flow enters through a 6-inch PVC pipe and high flow enters through a 9-inch PVC pipe. The opening of the 9-inch PVC pipe bends 90 degrees downward toward the facility floor. Flow drains through a 30-inch PVC pipe out of the riser. On the other side of the embankment, the flow drops 8 feet before being discharged by a 24-inch RCP to a plunge pool. Grouting has deteriorated at the seam 6 feet from the outfall. The outfall discharges with some incision. The plunge pool is 12 feet wide by 15 feet long and has some riprap displacement. The outflow has caused minor erosion and sedimentation of the natural channel behind the facility. The stream is in fair to good condition.

Figure A-61. Riser structure (left); Outfall and outfall channel from top of embankment (right)

Existing SWM000455 is located at the south end of Streamview Court behind residences, including 1302 Streamview Court. It has a fence and an 18-foot gate. The site is accessible from the road but has steep embankments. It is within the MSB-6 subwatershed. The facility consists of a dry pond that drains through a riser control structure to a natural channel. A 30-inch RCP conveys flows from residences on Streamview Court into the eastern part of the facility. Flows enter a riprap forebay and travel over riprap gabions before reaching the pond. The riprap is in good condition. A riprap channel conveys flows into

the northern tip of the facility. There is a minor amount of vegetation growing in the riprap. A 23-foot grass emergency spillway exists behind the riser structure on the southern border of the facility.

Figure A-62. Facility from behind the 30-inch RCP inflow pipe (left); Riser structure (right)

There was no rainfall observed in the area on the day of the site visit (4/30/19). There was 0.02 inch of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the southern border of the facility. Flows enter through a 4-inch PVC pipe orifice and discharge through a 30-inch RCP principal spillway. A plunge pool exists at the outfall where flows enter an unnamed tributary to Bynum Run. There is moderate channel erosion extending up to approximately 100 feet from the outfall, but the channel is stabilized beyond.

Figure A-63. Outfall and plunge pool (left); Downstream at outfall channel (right)

Existing SWM000469 is located behind residences off Kelsey Court, Blair Court, and Harling Court. It is accessible behind 1304 Harling Court. The site has a fence and gate and is well maintained. It is within the MSB-6 subwatershed. The facility consists of a dry extended detention pond that drains through a riser control structure to a natural channel. A riprap channel conveys flows from residences along Kelsey

Court and Brunswick Drive into the northern corner of the facility. There are three check dams in the channel upstream of the inflow channel. The riprap, channel, and dams are in good condition and are well maintained. A 24-inch RCP conveys flows from residences on Harling Court and most of Moonshadow Road into the eastern corner of the facility. The plunge pool has a moderate amount of vegetation growing in it. A riprap channel adjacent to the 24-inch RCP conveys flows into the same plunge pool. An 18-inch RCP conveys flows from Blair Court into a forebay in the western corner of the facility.

Figure A-64. Check dams upstream of facility (left); Facility and riser structure (right)

There was no rainfall observed in the area on the day of the site visit (4/30/19). There was 0.02 inch of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the southern border of the facility. Flows enter through a 2 inch by 2 inch concrete opening at the bottom of the pond and discharges through a 36-inch CMP principal spillway. A plunge pool exists at the outfall. A 22-foot wide grass emergency spillway exists above the principal spillway. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-65. Facility from behind the 18-inch RCP inflow pipe (left); Upstream at outfall and embankment (right)

Existing SWM000472 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000506 is located along Pulaski Highway (MD-40) immediately east of the 7-Eleven, 3901 Pulaski Highway. The location of the facility does not match the location in the database, which shows it in the wooded area behind Bush River Books & Video, 3909 Pulaski Highway. It is accessible from the 7-Eleven parking lot through a chain link swing gate. There is no other fencing around the facility. The facility is within the Bush River subwatershed. One 18-inch HDPE into the facility conveys flows originating from the storm sewer system that includes drainage from the 7-Eleven parking lot. A concrete riser structure controls flows out of the facility and discharges through an 18-inch CMP principal spillway. The principal spillway drains to a riprap ditch upstream of a 15-inch RCP running under the Bush River Books & Video driveway. There is no emergency spillway. No standing water or wetland vegetation were noted.

Looking at the facility with the Pulaski Highway (MD-40) behind it (left); Looking at the outfall and outfall channel (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observations), low flows enter the riser through an 18-inch CMP pipe constricted to 6-inch by an orifice plate. High flows enter the top of the riser through a trash rack. Currently flows in the roadside ditch along Pulaski Highway bypass the facility.

Figure A-66. Western side of the facility and access point from 7-Eleven (left); Confluence of outfall channel and roadside ditch (right)

Existing SWM000526 is located at the south end of Balmoral Drive, in front of the residences 1518 and 1522 Balmoral Drive. It has a fence and a gate that is easily accessible from the roadway. The facility is within the MSB-5 subwatershed. It consists of a dry extended detention pond that drains through a control structure to a natural channel. A riprap channel provides the only inflow to facility. It conveys flows from the residences to the west into the pond. The inflow is in good condition.

Figure A-67. Facing west towards facility and residences (left); Facility from top of riprap inflow point (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There were 1.45 inch of rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the eastern part of the facility. Flows enter through a 6-inch PVC pipe orifice that is buried under gravel. Flows discharge through a 24-inch CMP principal spillway that conveys flows under Balmoral Dr. A well-maintained plunge pool exists at the outfall where flows dissipate into the woods. The immediate outfall area was in good condition, and there was no observed downstream channel.

Figure A-68. Upstream view of outfall and outfall protection (left); Downstream view of outfall where flows enter the woods (right)

Existing SWM0554 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000597 is located behind the Lorien Bel Air assisted living center, 1909 Emmorton Road. It is accessible from the service driveway that runs behind the building. The facility is within the Atkisson Reservoir subwatershed. One 12-inch corrugated HDPE pipe conveys flows upstream of a riprap slope running into the facility from the storm sewer system to the northwest. The riprap slope shows minor erosion where it meets the bottom of the facility. A 30-inch RCP with concrete end section conveys flows into the facility from the southwest. A concrete riser structure controls flows out of the facility and discharges through a 27-inch RCP principal spillway. The downstream segment of pipe has become detached from the previous segment approximately 6 feet from the outfall. A riprap plunge pool at the outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the south. No ponding water or wetland vegetation were observed within the facility.

Figure A-69. View of facility from parking lot of Lorien Bel Air assisted living center (left); View of facility from riprap inflow point (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during

field work), a low-flow 12-inch perforated PVC pipe is installed at the pond floor. High flows enter a 6-inch RCP orifice, while overflow is conveyed through a three-sided weir with a U-shaped opening in the front.

Figure A-70. Riser control structure (left); Upstream view of outfall and embankment (right)

Existing SWM000621 is located off Sparrow Mill Way behind residences including 1154 through 1160 Sparrows Mill Way to the north and 1200 through 1204 Sparrow Mill Way to the south. The pond is functioning as a wet pond in its current condition and contains a decorative fountain. It is accessible from the homeowners association property between the residences at 1160 and 1200 Sparrows Mill Way. The facility is within the MSB-5 subwatershed. One 24-inch RCCP into the facility conveys flows originating from the storm sewer system to the north. One 24-inch RCCP into the facility conveys flows originating from the storm sewer system to the northwest. One 48-inch RCCP into the facility conveys flows originating from the storm sewer system to the south. Since the inflow pipes discharge below the permanent pool elevation, they are not visible, and the sizes and conditions could not be field verified. A concrete weir structure controls flows out of the facility and discharges through a Class II riprap principal spillway. The principal spillway drains to a channel ultimately discharging to Bynum Run to the south. There is a 32-foot grass emergency spillway along the northern edge of the pond. Wetland vegetation was present within the facility.

Figure A-71. View of facility from Sparrow Mill Way (left); Concrete weir and outfall protection (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the field site visit. Based on record drawings, base flows

exit the pond through a low flow release device consisting of a vertical 12-inch BCCMP pipe conveying flows through a 12-inch DIP drain discharging through the gabion basket wall downslope of the weir wall crest. High flows enter the weir and spill onto the gabion baskets and riprap spillway.

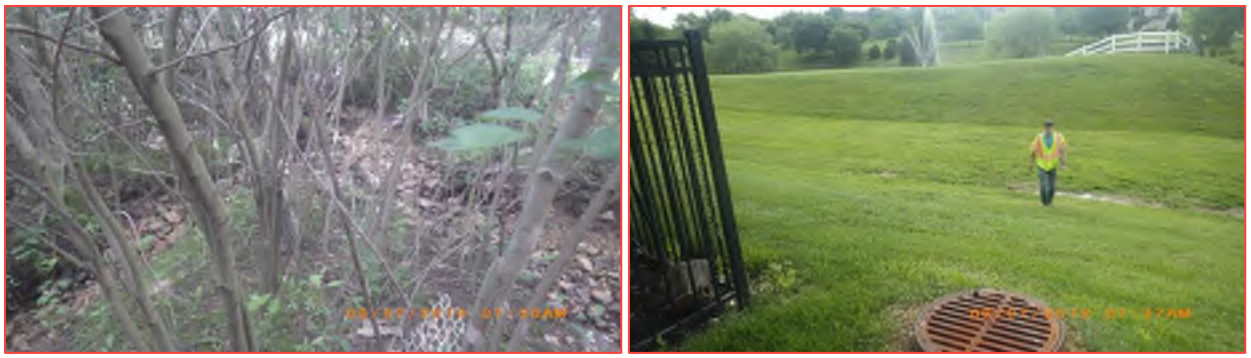

Figure A-72. Downstream view of outfall channel (left); Natural spring in emergency spillway channel from manhole on northern part of the facility (right)

Existing SWM000622 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000683 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000685 has a proposed BMP retrofit; more information on this site can be found in Appendix B.

Existing SWM000700 is located on the western side of Cedar Lane Regional Park behind the field with artificial turf. It is accessible from the western parking lot. The facility is surrounded by a fence and the outfall is only accessible through a chain link fence about 200 feet north of the facility. The area around the facility is used for recreation. The facility is within the LB-2 subwatershed. It consists of a dry pond that drains to a natural channel. A 24-inch HDPE inflow pipe with a plastic end section conveys flow from the east into the northern part of the facility and into a plunge pool. The plunge pool has some riprap displacement. A 24-inch HDPE with a plastic end section conveys flow from the east into the southern part of the facility. A wetland has formed at the south inflow.

Figure A-73. Wetland surrounding southern inflow pipe (left); Riser structure at northern end of facility (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). There was no rainfall observed in the area on the two days prior to the site visit. The concrete riser structure sits on the west side of the facility. Low flows enter through twin 6-inch PVC pipes with agri-drain caps at the bottom of the facility and discharge through a 24-inch CMP principal spillway. There is some standing water surrounding the twin low flow pipes. A 13-foot wide by 26-foot long plunge pool exists at the outfall. There is a minor amount of sediment in the outfall plunge pool. The outfall discharges to an unnamed tributary to Bynum Run. Minor soil erosion was observed.

Figure A-74. Facing north towards facility and riser structure (left); Upstream at outfall and outfall protection (right)

Existing SWM000704 is behind the Harford County Water and Sewer Division building at 3340 Abingdon Road. It is accessible from the parking area south of the building. The facility is within the MSB-3 subwatershed. Based on field observation and per a conversation with a County employee, the location was retrofitted three to four years ago. Retrofits included micro-bioretention along a series of yard inlets along the northeast side of the building and a check dam system leading from the parking lot. Flows from both treatment areas are conveyed to the existing pond immediately northwest of the transmission tower.

Figure A-75. Downstream end of check dams (left); Upstream end of check dams (right)

Figure A-76. Micro-bioretentions (left); Yard inlet that conveys flows to existing pond (right)

Existing SWM000761 is located on the north end of Cedar Lane Regional Park surrounded by recreational fields. It is accessible from the northern most parking lot. There is no fence surrounding the facility. There is a chain link fence separating the riser from the outfall, and the closest fence opening is 200 feet east of the facility. It is within the LB-2 subwatershed. It consists of a dry pond that is routed through a riser control structure and drains to a natural channel. A 12-inch CMP with metal end section conveys flow from the southern fields into a sloped plunge pool on the southeast part of the facility. There is minor erosion above the inflow pipe. A 15-inch HDPE with plastic end section conveys flow from a southern parking lot into a 48-foot long by 8-foot wide plunge pool on the southwest part of the facility. There was major clogging of the HDPE by riprap that the field workers removed. A 27-foot grass emergency spillway is located on the west side of the facility.

Figure A-77. Facing north towards facility (left); Facing northwest towards facility from foot path above southeastern inflow point (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). There was no rainfall observed in the area on the two days prior to the site visit. A cylindrical aluminum riser structure sits at the northern most point of the facility. The riser is 39 inches in diameter and 22 inches high, and it is elevated 19 inches off the ground by a smaller aluminum cylinder. A 6-inch CMP with trash rack conveys flow into the riser and a 12-inch CMP drains flow to the principal spillway. A plunge pool exists at the outfall and flow is conveyed into an unnamed tributary to Bynum Run. The plunge pool has major sediment built up in the riprap. Most of the riprap has been displaced. There are wetland plants in the plunge pool. There is minimal erosion from the outfall into the natural channel and the outfall area 100 feet downstream is in good condition.

Figure A-78. Riser and low flow orifice (left); Downstream view of outfall protection an outfall channel (right)

Existing SWM000769 is located behind the tennis courts of Patterson Mill Jr-Sr High School. It is accessible from a paved walking path that connects to the school's eastern parking lot. The site has no fence and is well maintained. The facility is within the MSB-5 subwatershed. It consists of a shallow wetland that drains through a CMP principal spillway to a natural channel. An 18-inch RCP conveys flows from the tennis courts into the pond. The pipe was underwater during the site visit. A 21-inch RCP conveys flows from the parking lot into the pond. The pond has two PVC pipe observation wells in the standing water area.

Figure A-79. Facing north toward facility (left); PVC pipe observation well in shallow wetland (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There was 1.45 inches of rainfall in the area on the two days prior to the site visit. An 18-inch RCP principal spillway exists on the eastern tip of the facility. The pipe was submerged during the site visit. Flows are conveyed through the pipe, which transitions to a 24-inch RCP, and into a plunge pool. Outflow drains into an unnamed tributary to Bynum Run. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure A-80. Outfall and plunge pool (left); Facing west towards paved walking path leading to school parking lot (right)

Existing SWM000775 is located north of Patterson Mill Jr-Sr High School's western parking lot. It has no fence and is accessible from the parking lot. The facility is within the MSB-5 subwatershed. It consists of two forebays that drain to a shallow wetland. The wetland drains through a riser control structure to a natural channel. A 24-inch RCP conveys flows from the school's roof and part of the parking lot into the eastern forebay. The field team was unable to see this inflow pipe during their site visit. A 21-inch RCP

conveys flow from the parking lot and the field team could not see the pipe during their site visit. An 18-inch RCP conveys flow from the northwest into the forebay. It was visible, but half filled with water.

Figure A-81. Facility from behind the 18-inch RCP inflow pipe (left); 18-inch RCP inflow pipe (right)

There was no rainfall observed in the area on the day of the site visit (5/14/19). There was 1.45 inches of rainfall in the area on the two days prior to the site visit. The concrete riser structure, which sits on the northern border of the facility, was unable to be located under the thick vegetation. Flows enter through a 4-inch PVC pipe orifice and discharge through a 24-inch RCP. The immediate outfall area extending to approximately 100 feet downstream is so severely overgrown with bamboo that the field team could not verify the outfall condition. The outflow connects to an unnamed tributary to Bynum Run.

Figure A-82. Facility northern border adjacent to Patterson Mill Road (left); Overgrown outfall area (right)

Existing SWM000785 is located behind Patterson Mill Middle High School, 85 Patterson Mill Road. It is accessible from school property as well as from a wooded area at the end of Wetterhorn Drive to the southeast. The facility is within the MSB-4 subwatershed. One 30-inch RCP conveys flows into the facility forebay from the storm sewer system to the west. Flows exit the treatment pond through a control

structure located underground and discharge through a 24-inch RCP principal spillway. The downstream segment of pipe has become detached from the previous segment approximately 6 feet from the outfall. A riprap plunge at the outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the southwest. Ponded water and abundant wetland vegetation were observed within the facility.

Figure A-83. Facing north towards facility (left); Facing south towards facility (right)

Rainfall totaling 0.02 inch had been observed in the area on the day of the site visit (5/16/19). The pond is functioning as a wet facility in its current condition. Based on record drawings, a low-flow 6-inch DIP at the pond bottom is equipped with a 6-inch valve. With the valve in closed state, a permanent pool results with high flows entering a 24-inch RCP and discharging downstream though a 24-inch RCP spillway.

Figure A-84. Facing downstream towards outfall and outfall channel (left); Facing upstream at outfall and outfall protection (right)

Existing SWM0807(1)/SWM000807 could not be located during field investigations. GIS information indicates it is located northeast of the intersection of Starmount Lane and Chateau Green Court behind residences including 1236 through 1242 Chateau Green Court. The GIS location is within the MSB-5 subwatershed. The as-built for this site matches SWM000312.

Figure A-85. GIS location for facility SWM0807(1) / SWM000807

Existing SWM000813 is located behind residences, including 1602 Willowdale Drive. It does not have a fence and is well maintained. The site is accessible from the road and is within the LB-1 subwatershed. The facility consists of a dry pond that drains through a riser control structure into the nearby woods. There is one inflow pipe and one inflow channel. A 24-inch RCP conveys flow from Willowdale Drive to the eastern part of the facility. The inflow is in good condition. A long riprap channel conveys flow from residences along Willowdale Drive and Beechview Court into the northeastern part of the facility. The riprap channel is in good condition.

Figure A-86. Facing north towards riser structure and riprap inflow point (left); Facing east towards both inflow points (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the southern border of the facility. Low flows enter through a 5-inch by 5-inch orifice in the concrete with a circular 5-inch PVC pipe lining it. Flows discharge through a 24-inch RCP principal spillway. A plunge pool exists at the outfall where flows dissipate into the woods. There was no observed downstream channel, but the immediate outfall area was in good condition.

Figure A-87. Facing east towards facility (left); Facing downstream at outfall and outfall protection (right)

Existing SWM000814 is located behind residences, including 1600 Willowdale Drive. It does not have a fence and is well maintained. The site is accessible from the road. It is within the LB-1 subwatershed. The facility consists of a dry pond that drains through a riser control structure into the nearby woods. The only inflow is a 15-inch RCP that conveys flows from Beechview Court and a few residences on Willowdale Drive. The inflow riprap has a minor amount of sediment.

Figure A-88. Facing west towards the RCP inflow pipe and riser structure (left); Facing east towards facility (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the southern border of the facility. Flows enter through a 5-inch by 5-inch orifice in the concrete and discharge through a 24-inch RCP principal spillway. An 80-foot long plunge pool exists at the outfall where flows dissipate into the woods. There was no observed downstream channel, but the immediate outfall area was in good condition.

Figure A-89. View of downstream outfall and outfall channel (left); Upstream view of outfall and outfall protection (right)

Existing SWM000815 is located behind residences, including 1504 Willowdale Drive. It is accessible between 1504 and 1502 Willowdale Drive. The site does not have a fence and is well maintained. It is within the LB-1 subwatershed. The facility consists of a dry pond that drains through a riser control structure into the nearby woods. The only inflow is a 24-inch RCP that conveys flows from residences along Willowdale Drive. The inflow has moderate sediment build up. A 12-foot grass emergency spillway exists along the northeastern part of the facility.

Figure A-90. View of facility from behind RCP inflow (left); 5-inch by 5-inch orifice (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). There was no rainfall in the area on the two days prior to the site visit. The concrete riser structure sits on the eastern border of the facility. Flows enter through a 5-inch by 5-inch orifice in the concrete and discharge through a 24-inch RCP principal spillway. A 36-foot long plunge pool exists at the outfall where flows dissipate into the woods. There was no observed downstream channel, but the immediate outfall area was in good condition.

Figure A-91. Downstream view of outfall and outfall channel (left); Upstream view of channel and outfall protection (right)

Existing SWM000892 is located north of Cedarday Drive. It receives flows from roadways and is in the LB-1 subwatershed. It is accessible via a swing gate off the road. The facility consists of a sediment forebay and a dry pond. Flow drains out of the facility into a natural channel. A 15-inch RCP at the southern part of the facility is the only inflow point. It conveys flow into the facility from drainage ditches on either side of the roadway to the east. Flow enters the facility at riprap outlet protection. There is minor sediment build up in the plunge pool. Overflow from the plunge pool drains over a riprap weir into the sediment forebay. A 6-inch PVC pipe conveys flow from the bottom of the sediment forebay into the dry pond.

Figure A-92. Facing southeast towards the facility (left); Sediment forebay (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). There was no rainfall observed in the area on the two days prior to the site visit. The concrete riser structure sits in the western part of the facility. Flow enters through a 6-inch PVC plated pipe at the bottom of the pond and it drains through a 24-inch RCP with an end section at the outfall. An 18-foot wide by 20-foot long plunge pool exists at the outfall. There is standing water in the plunge pool, but the riprap is in good condition. There was no observable outfall erosion leading down to an unnamed tributary to Bynum Run.

Figure A-93. Embankment behind riser structure (left); Downstream view of outfall and plunge pool (right)

APPENDIX B BMP PROJECTS

BMP field findings identified areas within the Lower Bynum Run watershed where potential restoration projects have the opportunity to protect infrastructure, improve water quality, and/or reduce flooding. These projects fall into two categories: BMP retrofits and new BMP facilities. A total of 13 BMP retrofits and 2 new BMP projects have been recommended. Table B-1 lists all 15 BMP projects.

Each project description begins with an "at a glance" summary of the recommended restoration, the location of the project, the number of properties impacted, the pollutant load reductions and impervious area treated. The project description also includes a site description, recommended actions, threats to infrastructure, impacted property addresses, a cost estimate, and a map showing the extents of the project.

BMP projects listed below have been separated into two sections, existing BMP retrofits and new BMP projects. Due to a high percentage of residential land use within the watershed and limited right of way space adjacent to streets, space is limited within this watershed for the construction of BMPs. The types of retrofits and new BMPs being recommended include bioretention, submerged gravel wetlands, and a wet pond.

Project costs for BMPs were calculated using three different methods. For the wet pond, BMP construction costs were estimated based on the BMP type and cost per impervious area treated (King & Hagan, 2011). The King and Hagen document uses 2011 dollars; the construction costs were inflated to 2019 values. For the submerged gravel wetlands, construction costs were calculated using the average material costs of BMP components along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs. For the bioretention, construction costs were based on actual Maryland bioretention construction costs and engineering judgement. Design costs for BMP types were estimated as a percentage of the construction costs to provide total project costs.

Table B-1. Existing and Proposed BMP Retrofit Summary

PROJECT NAME	TYPE	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	IMPERVIOUS AREA TREATED (ACRES)	TN REDUCTIONS (LBS/YR)	TP REDUCTIONS (LBS/YR)	TSS REDUCTIONS (LBS/YR)	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
SWM0554	Extended Detention Retrofit	18.27	3.09	3.18	48.11	7.07	18,058	$261,253	$82,085
SWM000118	Submerged Gravel Wetland	7.32	2.27	1.00	46.82	3.17	6,660	$103,251	$103,375
SWM000257	Submerged Gravel Wetland	9.13	2.37	2.44	81.27	5.75	11,986	$214,570	$87,899
SWM000287	Submerged Gravel Wetland	6.26	1.81	2.52	61.74	4.24	8,934	$258,475	$102,736
SWM000312	Submerged Gravel Wetland	3.52	1.39	1.70	37.13	2.36	5,044	$209,402	$123,483
SWM000342	Submerged Gravel Wetland	3.05	0.68	0.75	27.58	2.01	4,166	$113,519	$151,764
SWM000347	Submerged Gravel Wetland	4.58	1.65	2.08	47.23	3.08	6,553	$259,395	$124,769
SWM000415	Submerged Gravel Wetland	11	3.76	3.84	102.63	6.80	14,373	$300,984	$78,479
SWM000428	Submerged Gravel Wetland	6.09	1.55	2.05	58.31	4.12	8,632	$288,689	$141,099
SWM000472	Submerged Gravel Wetland	11.48	3.31	4.37	112.65	7.76	16,330	$511,508	$117,071
SWM000622	Submerged Gravel Wetland	2.46	0.31	0.42	21.09	1.67	3,415	$80,864	$193,224
SWM000683	Submerged Gravel Wetland	3.41	1.18	1.51	34.83	2.30	4,877	$208,985	$138,364
SWM000685	Submerged Gravel Wetland	14.67	3.93	4.52	139.04	9.76	20,395	$450,193	$99,611
BMP-P-4	Bioretention	1.08	0.52	0.71	12.29	0.73	1,591	$150,394	$212,661
BMP-P-7	Bioretention	1.99	1.34	1.37	22.93	1.21	2,699	$165,384	$121,001
Total		**104.31**	**29.16**	**32.46**	**853.64**	**62.05**	**133,714**	**$3,576,866**	

B.1 EXISTING BMP RETROFITS

The field assessment of 65 existing dry detention BMPs within the Lower Bynum Run watershed resulted in 13 with potential retrofit opportunities. The 13 facilities currently provide stormwater quantity control. Retrofitting these 13 BMPs would provide impervious area credit for these facilities as well as pollutant load reductions. Although retrofitting the dry detention pond to become wet ponds is usually the most cost effective option, only one wet pond is proposed. This is because the surface waters in the watershed in all but one of the dry ponds are designated as Use III – nontidal cold water (COMAR, 2014), and wet ponds are discouraged in these areas. The one wet pond proposed is in an area where the surface waters are designated as Use I - Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life, where wet ponds are allowed.

Another BMP retrofit possibility is an infiltration trench below the bottom of the pond. This option was rejected because it is likely that the soil in these ponds are compacted and would not allow stormwater to infiltrate within the 2-day window allowed for this BMP. Bioretention in the pond bottom was also rejected because they would likely require underdrains, and the existing risers in the pond did not have enough head to allow an underdrain connection.

The BMP that was proposed for the remaining 12 facilities is submerged gravel wetland. This BMP is not designed to infiltrate, so soil compaction is not an issue. It also does not require an underdrain and only needs minimal head, which would work in these facilities. Each of the 13 retrofit projects is described in detail in this section. Chapter 4 provides background information on the field identification process.

RETROFIT OF EXISTING SWM0554: EXTENDED DETENTION RETROFIT

Project Description	Retrofit existing extended detention facility (Existing SWM0554) with wet pond
Location	Smiths Landing Court
Property Ownership	Smiths Landing Homeowners Association, Inc.
Subwatershed	MSB-1
Potential Impervious Acres Treated	3.18 Acres
Potential Load Reductions TP	48.11 lbs/year
Potential Load Reductions TN	7.07 lbs/year
Potential Load Reductions TSS	18,058 lbs/year
Estimated Design/Construction Costs	$261,253 $82,085/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM0554 is an extended detention facility with a shallow marsh located off Smiths Landing Court behind residences including 4043 Smiths Landing Court and 4045 Smiths Landing Court (Figure B-1). A split row wooden fence with a gate encloses the facility. It is accessible via the Homeowners Association property adjacent to 4029 Smiths Landing Court (Figure B-2). The facility is within the MSB-1 subwatershed. One 36-inch CMP into the facility conveys flows originating from the storm sewer system

to the south and west. There is a concrete riser structure controls with a 30-inch CMP principal spillway. The principal spillway outlets to a channel discharging to an unnamed tributary to Bush Creek (use I). There is no emergency spillway. Standing water was observed at the inflow point of the 36-inch CMP. Wetland vegetation was present within the facility.

Figure B-1. Wetland vegetation around the riser and inflow pipe (left); Embankment behind the riser structure (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observations), the facility dewaters through a 12-inch pipe constricted by a 2-inch orifice plate. The riser structure has a 10-inch low flow CMP and a 2-foot wide high flow weir at the front of the open-top riser with trash racks.

Figure B-2. Access path behind residences on Smiths Landing Court (left); Continuing view of access to facility (right)

- Drainage Area: 18.27 Acres
- Impervious Drainage Area: 3.09 Acres

<u>Recommended Restoration Actions</u>

- A wet pond retrofit is recommended to target improved water quality for flow exiting the facility into the perennial stream. Permanent pools excavated down from the existing dry pond bottom are to be created to improve water quality.

- A forebay can be placed at the inflow to slow flow entering the facility and reduce sediment loadings.
- Proposed retrofit plans are shown in Figure B-3.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Smith's Landing Association, Inc.

Access

- Good Access: The existing facility is located on communal HOA land and is accessed from Smiths Landing Court. Moderately steep slopes and a fence surround the entire existing extended detention basin. There is a chain-link gated access.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP SWM0554 are shown in Table B-2. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed wet pond treats 1.12 inches of rainfall which corresponds to 1.03 impervious acre credit per acre of watershed impervious area. This proposed wet pond would provide 3.18 impervious acres of treatment.

While the existing BMP does provide stormwater quantity control, the proposed wet pond retrofit will also target water quality. Wet ponds provide a pollutant load reduction of 20% for nitrogen, 45% for phosphorus, and 60% for sediment (MDE, 2011).

Items of Note

There may be concerns from the community about the conversion from dry to wet pond as the pond will look different because of the permanent wet pool. Community outreach/buy in should be obtained early to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $261,253 for retrofitting existing SWM0554. Project costs are broken down by cost per impervious acre treated (Table B-3). BMP construction costs were estimated based on the BMP type and cost per impervious area treated (King & Hagan, 2011). The King and Hagen document uses 2011 dollars; the construction costs were inflated to 2019 values. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-2: Summary of Improvements for Existing SWM0554

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM00554	18.27	3.09	-	3.18	48.11	7.07	18,058
Outfall								
Stream								
Total Credit/ Reductions					3.18	48.11	7.07	18,058

Table B-3: Summary of Project Costs for Retrofitting Existing SWM0554

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000554	$261,253	$82,085
Outfall			
Stream			
Total Costs		$261,253	$82,085

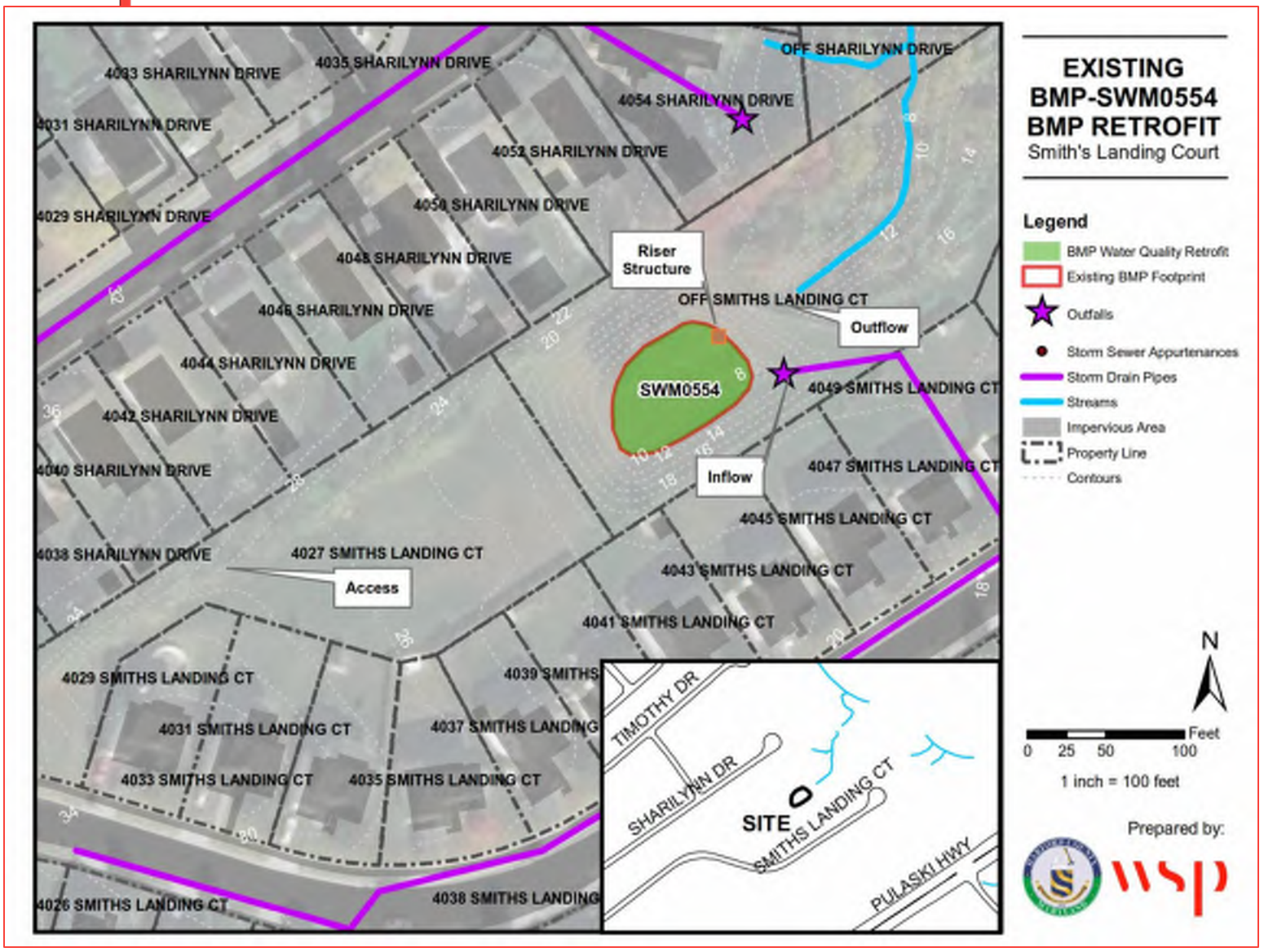

Figure B-3: Site Location and Proposed Retrofit for Existing SWM0554

RETROFIT OF EXISTING BMP-SWM000118: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of existing extended detention facility (Existing BMP-SWM000118) with a submerged gravel wetland
Location	Behind the property at 34 Mitchell Drive
Property Ownership	Box Hill Community Services
Subwatershed	MSB-4
Potential Impervious Acres Treated	1.00 Acres
Potential Load Reductions TP	46.82 lbs/year
Potential Load Reductions TN	3.17 lbs/year
Potential Load Reductions TSS	6,660 lbs/year
Estimated Design/Construction Costs	$103,251 $103,375/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM000118 is an extended detention facility surrounded by residences including 34 Mitchell Drive. It can be accessed between 24 Mitchell Drive and 28 Mitchell Drive. The facility is bordered by a gated chain link fence and is well mowed. It is within the MSB-4 subwatershed. A 24-inch RCP conveys flows from residences along Mitchell Drive into a riprap outlet protection on the western tip of the facility. The metal apron has major rust damage. There is minor sediment build up and minor riprap displacement in the outlet protection. The channel conveying flow from the inflow to the center of the facility cuts into the ground (Figure B-4).

Figure B-4. The 24-inch RCP inflow pipe and riprap outlet protection (left); The channel from the inflow pipe to the facility (right)

There was 0.47-inch of rainfall observed in the area on the day of the site visit (5/23/19). No rainfall was observed during the two days prior to the field site visit. There is a concrete riser structure in the center of the facility. Low flows entering through a 4-inch PVC orifice with headwall and trash rack. High flows enter the riser through a 17-inch wide by 29-inch tall concrete weir on the riser. Flows discharge through a 15-inch CMP principal spillway and enter an unnamed tributary to Bynum Run. Riprap exists at the

outfall with no observed outfall erosion or sediment build up. The stream extending to approximately 100 feet downstream of the outfall was in good condition (Figure B-5).

Figure B-5. Riser structure and embankment behind it (left); downstream at the outfall channel (right)

- Drainage Area: 7.32 Acres
- Impervious Drainage Area: 2.27 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the western portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-6.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Box Hill Community Services

Access

- Good Access: Access through an easement between 24 Mitchell Drive and 28 Mitchell Drive.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000118 are shown in Table B-4. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 0.44 inch of rainfall which corresponds to 0.44 impervious acre credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 1.00 impervious acre of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 43% for nitrogen, 50% for phosphorus, and 54% for sediment (MDE, 2014a).

Items of Note

There may be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $103,251 for retrofitting existing BMP-SWM000118. Project costs are broken down by cost per impervious acre treated (Table B-5). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-4: Summary of Improvements for Existing BMP SWM000118

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000118	7.32	2.27	-	1.00	46.82	3.17	6,660
Outfall								
Stream								
Total Credit/ Reductions					1.00	46.82	3.17	6,660

Table B-5: Summary of Project Costs for Retrofitting Existing BMP SWM000118

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000118	$103,251	$103,375
Outfall			
Stream			
Total Costs		$103,251	$103,375

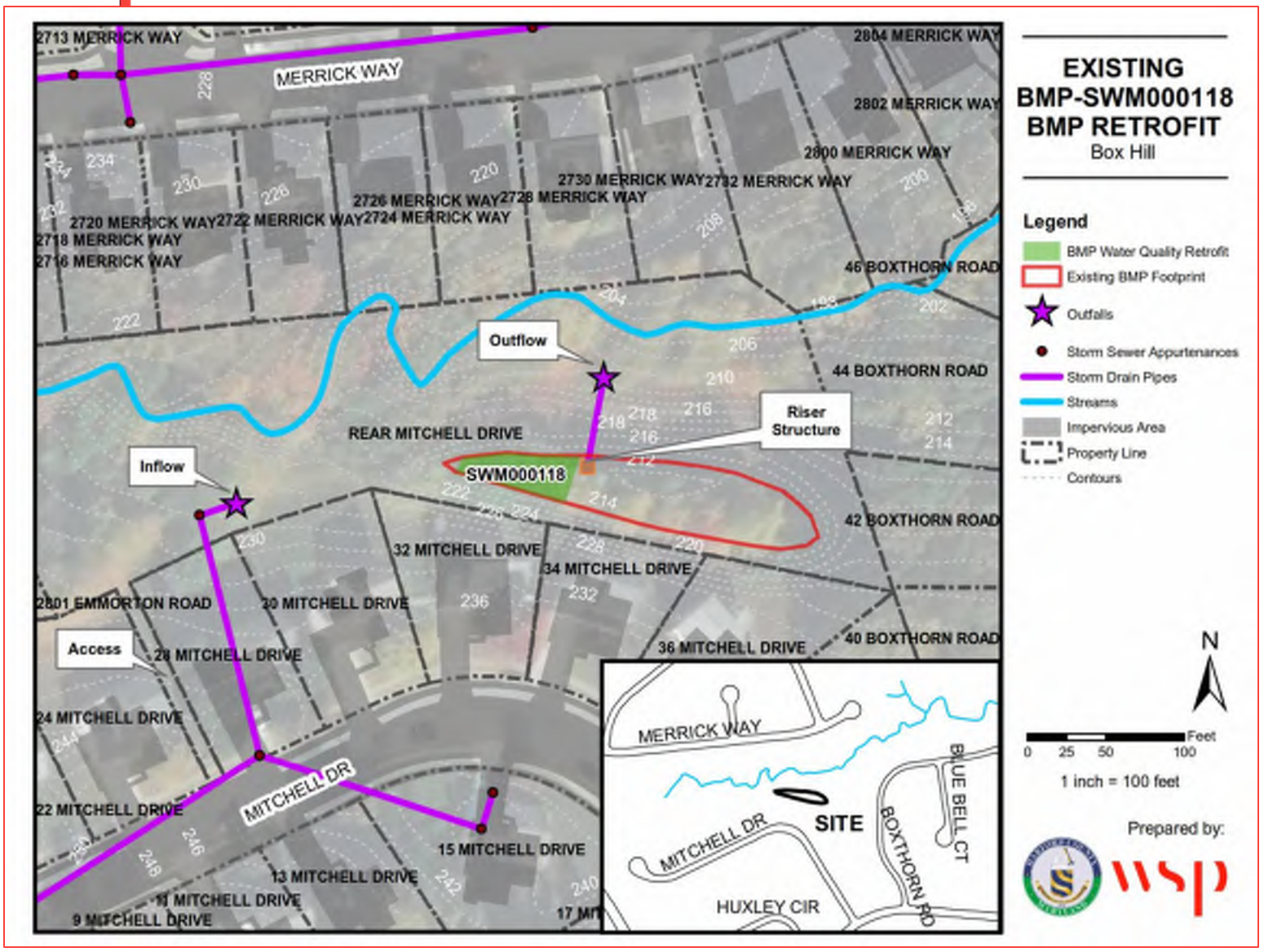

Figure B-6. Site Location and Proposed Retrofit for Existing BMP-SWM000118

RETROFIT OF EXISTING BMP-SWM000257: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000257) with a submerged gravel wetland
Location	Behind the property at 803 Deepwood Court
Property Ownership	Cedarday Community
Subwatershed	MSB-4
Potential Impervious Acres Treated	2.44 Acres
Potential Load Reductions TP	81.27 lbs/year
Potential Load Reductions TN	5.75 lbs/year
Potential Load Reductions TSS	11,986 lbs/year
Estimated Design/Construction Costs	$214,570 $87,899/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM000257 is an extended detention facility located north of Deepwood Court, behind the residential properties of 803 Deepwood Court and 805 Deepwood Court. It is surrounded by a chain link fence and is accessible from a 12-foot wide access road and an 18-foot swing gate. The facility is within the MSB-4 subwatershed. The facility has two inflow points. One is a 30-inch RCP with headwall in the eastern part of the facility. Water has pooled at the inflow point to a depth of 8 inches and there is wetland vegetation around the pool. The second is a 21-inch RCP with a 14-foot long headwall in the southern part of the facility. Water has pooled at the inflow point and there is wetland vegetation surrounding the pool (Figure B-7). There is a 22-foot emergency spillway with riprap in the southwest part of the facility. The slope above the southern inflow is reinforced with riprap in good condition. The slopes of the facility are steep, except for the vehicle access path.

Figure B-7. The southern inflow point and the riser structure (left); The eastern inflow point and the pool in front of it (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). No rainfall was observed during the two days prior to the field site visit. The concrete riser structure sits at the northern part of the facility. The riser has a 6-inch PVC low flow orifice. At 11 feet away from the riser, the low flow orifice extends vertically 5 feet and is supported by gravel. The riser has an 18-inch CMP about halfway up.

There is a weir above that equipped with a trash rack for high flows. The riser outlet is a 36-inch RCP with a 17-foot long headwall (Figure B-8). There is a 12-foot-wide by 21-foot-long riprap protection at the outfall where flow enters Bynum Run confluent to James Run to the northwest. The immediate outfall area extending to approximately 100 feet downstream is in good condition.

Figure B-8. The embankment behind the riser structure (left); Outfall headwall (right)

- Drainage Area: 9.13 Acres
- Impervious Drainage Area: 2.37 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the eastern portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-9.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Cedarday Community

Access

- Good Access: Access from ROW between two residences via easement.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000257 are shown in Table B-6. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.11 inches of rainfall which

corresponds to 1.03 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 2.44 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 63% for nitrogen, 73% for phosphorus, and 78% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $214,570 for retrofitting existing BMP-SWM000257. Project costs are broken down by cost per impervious acre treated (Table B-7). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-6: Summary of Improvements for Existing BMP SWM000257

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000257	9.13	2.37	-	2.44	81.27	5.75	11,986
Outfall								
Stream								
Total Credit/ Reductions					2.44	81.27	5.75	11,986

Table B-7: Summary of Project Costs for Retrofitting Existing BMP SWM000257

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000257	$214,570	$87,899
Outfall			
Stream			
Total Costs		$214,570	$87,899

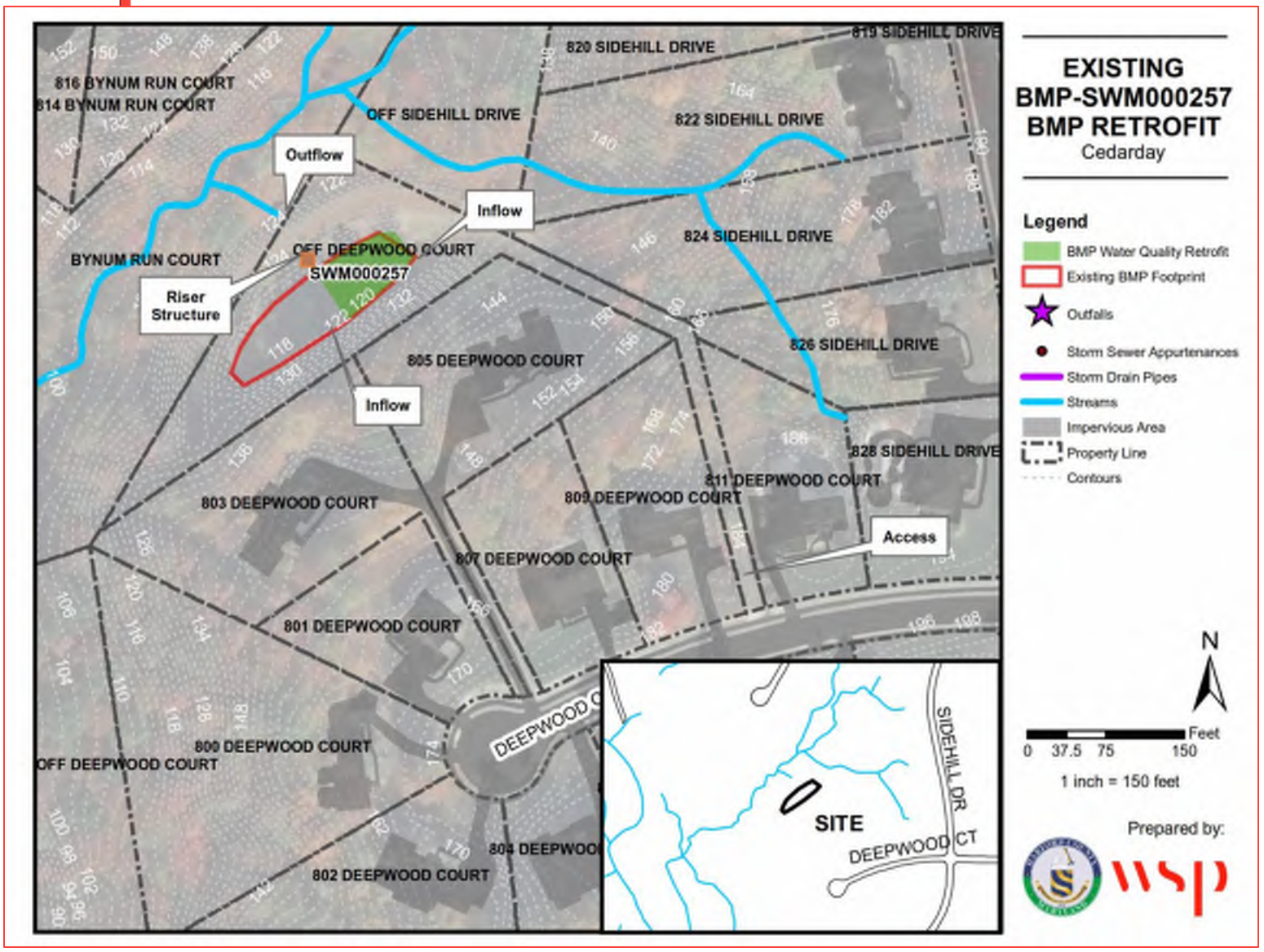

Figure B-9. Site Location and Proposed Retrofit for Existing BMP-SWM000257

RETROFIT OF EXISTING BMP-SWM000287: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000287) with a submerged gravel wetland
Location	Behind the property at 3301 Pouska Road
Property Ownership	Village of Bynum Run I
Subwatershed	MSB-3
Potential Impervious Acres Treated	2.52 Acres
Potential Load Reductions TP	61.74 lbs/year
Potential Load Reductions TN	4.24 lbs/year
Potential Load Reductions TSS	8,934 lbs/year
Estimated Design/Construction Costs	$258,475 $102,736/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM000287 is an extended detention facility located southeast of the intersection of Gittings Court and Pouska Road, and behind residences 3301 Pouska Road and 899 Gittings Court. It is accessible from Pouska Road adjacent to 3305 Pouska Road. The facility is within the MSB-3 subwatershed. One 18-inch CMP into the facility conveys flows originating from the storm drainage system to the northwest. Another 18-inch CMP into the facility conveys flows originating from the storm drainage system to the northeast. There is a concrete riser structure that discharges through a 24-inch BCCMP principal spillway, which drains to a channel discharging to an unnamed tributary to Bynum Run to the south (Figure B-10). One to three inches of standing water and wetland vegetation were observed in the facility.

Figure B-10. The riser structure, pond, and the northwest inflow pipe (left); Facing southwest towards the facility from the manhole above the northwest inflow pipe (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07 inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field observations), there is an 8-inch BCCMP in the riser for low flows. There is no emergency spillway (Figure B-11).

Figure B-11. Riser structure (left); The outfall channel (right)

- Drainage Area: 6.26 Acres
- Impervious Drainage Area: 1.81 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended in the extended detention basin footprint. The submerged gravel wetland would have a forebay at each inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-12.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Village of Bynum Run I

Access

- Fair Access: Access from ROW between a residence and the natural stream.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000287 are shown in Table B-8. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.60 inches of rainfall which corresponds to 1.40 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 2.52 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 68% for nitrogen, 79% for phosphorus, and 85% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $258,475 for retrofitting existing BMP-SWM000287. Project costs are broken down by cost per impervious acre treated (Table B-9). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-8: Summary of Improvements for Existing BMP SWM000287

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000287	6.26	1.81	-	2.52	61.74	4.24	8,934
Outfall								
Stream								
Total Credit/ Reductions					2.52	61.74	4.24	8,934

Table B-9: Summary of Project Costs for Retrofitting Existing BMP SWM000287

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000287	$258,475	$102,736
Outfall			
Stream			
Total Costs		$258,475	$102,736

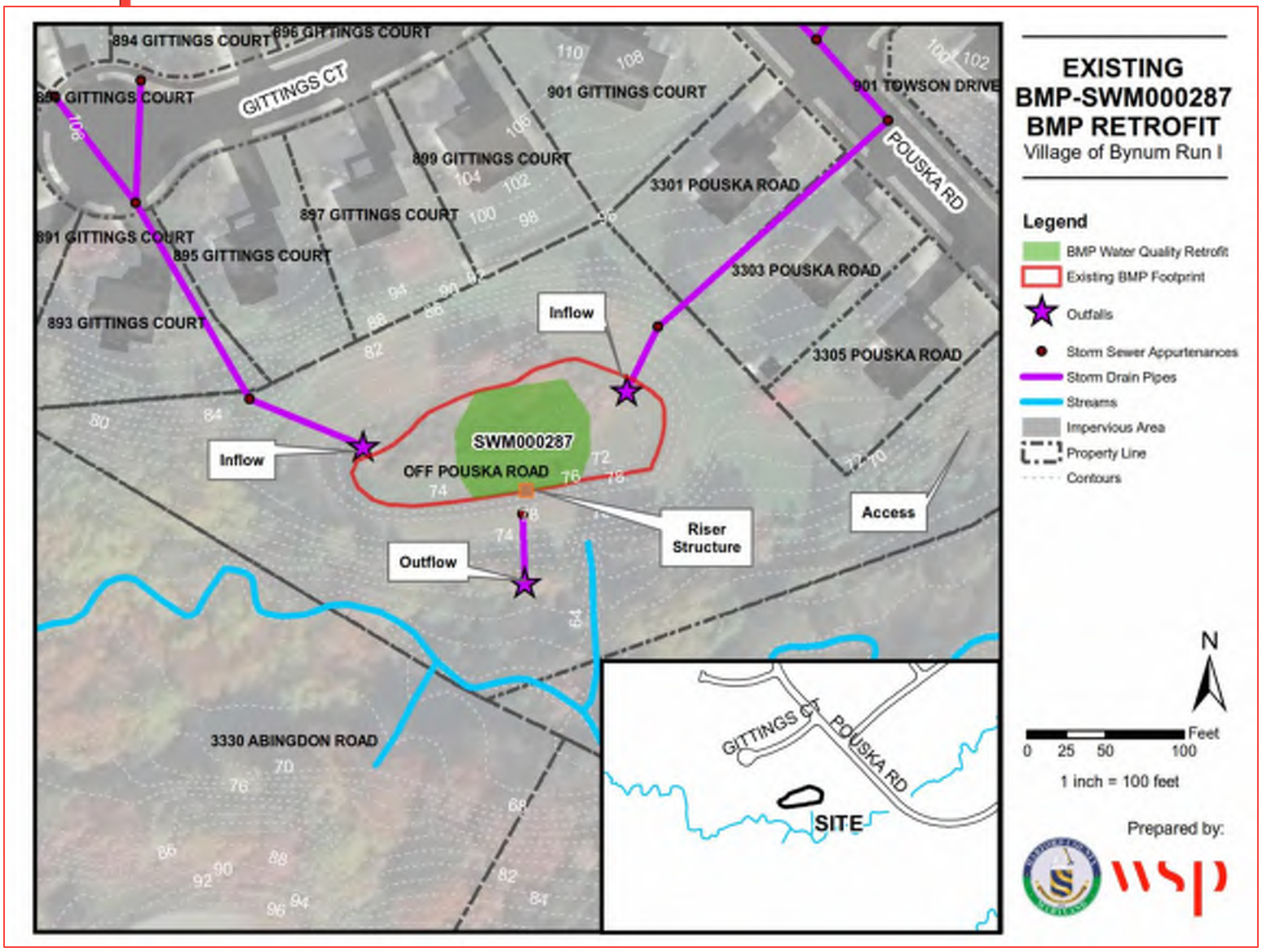

Figure B-12. Site Location and Proposed Retrofit for Existing BMP-SWM000287

RETROFIT OF EXISTING BMP-SWM000312: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000312) with a submerged gravel wetland
Location	Behind the property at 210 Royal Oak Drive
Property Ownership	Bright Oaks Village Townhomes
Subwatershed	MSB-4
Potential Impervious Acres Treated	1.70 Acres
Potential Load Reductions TP	37.13 lbs/year
Potential Load Reductions TN	2.36 lbs/year
Potential Load Reductions TSS	5,044 lbs/year
Estimated Design/Construction Costs	$209,402 $123,483/impervious acre treated
Adjacent Projects	MSB-4A Stream and Outfall Restoration

Site Description

Existing SWM000312 is an extended detention facility located at the intersection of Ranier Avenue and Royal Oak Drive behind residences, including 210 Royal Oak Drive. It is well maintained and accessible from Royal Oak Drive. It has a chain link fence around the embankment and an 18-foot gate on its border with Ranier Avenue. It is within the MSB-4 subwatershed. There are two inflow pipes to the facility. On the western part of the facility, an 18-inch BCCMP conveys flow into a water quality basin. There was less than 6 inches of standing water and wetland vegetation in the basin. The metal end section has major rust damage. Another 18-inch BCCMP with metal end section conveys flows from residences along Royal Oak Drive into the eastern part of the facility. There is a plunge pool at this inflow, and it is in good condition. An 11.5-foot grass emergency spillway exists at the northern edge of the facility (Figure B-13).

Figure B-13. Rusted 18-inch inflow pipe (left): Facility view from emergency spillway (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). No rainfall was observed during the two days prior to the field site visit. There is a concrete riser structure at the northern end of

the facility with an 8-inch PVC pipe orifice inflow and an 18-inch CMP principal spillway outflow (Figure B-14). Riprap protection exists at the outfall and flows into an unnamed tributary to Bynum Run 25 feet from the outfall. The end section of the outfall is rusted and there is moderate riprap displacement. The stream area extending approximately 100 feet downstream is in good condition.

Figure B-14. Riser structure and emergency spillway in the background (left): Outfall (right)

- Drainage Area: 3.52 Acres
- Impervious Drainage Area: 1.39 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the western portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-15.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Bright Oaks Village Townhomes

Access

- Good Access: Access from Royal Oak Drive.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000312 are shown in Table B-10. The table includes the drainage area, the impervious area within the drainage area, the impervious area

treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.88 inches of rainfall which corresponds to 1.22 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 1.70 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 67% for nitrogen, 78% for phosphorus, and 84% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $209,402 for retrofitting existing BMP-SWM000312. Project costs are broken down by cost per impervious acre treated (Table B-11). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-10: Summary of Improvements for Existing BMP SWM000312

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000312	3.52	1.39	-	1.70	37.13	2.36	5,044
Outfall								
Stream								
Total Credit/ Reductions					1.70	37.13	2.36	5,044

Table B-11: Summary of Project Costs for Retrofitting Existing BMP SWM000312

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000312	$209,402	$123,483
Outfall			
Stream			
Total Costs		$209,402	$123,483

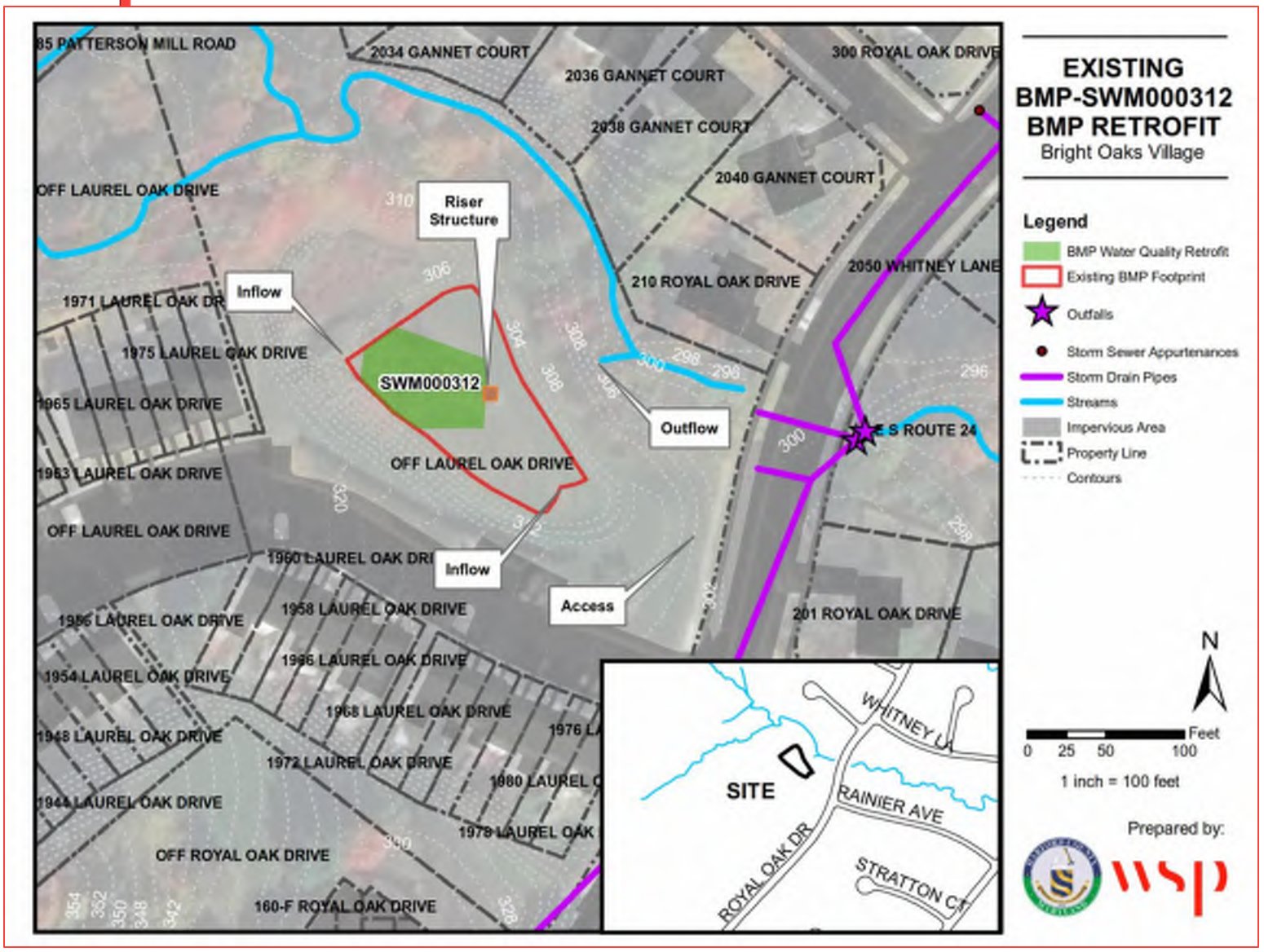

Figure B-15. Site Location and Proposed Retrofit for Existing BMP-SWM000312

RETROFIT OF EXISTING BMP-SWM000342: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of existing extended detention facility (Existing BMP-SWM000342) with a submerged gravel wetland
Location	Behind the property at 511 Cedar Hill Court
Property Ownership	Cedar Hill Homeowners
Subwatershed	MSB-4
Potential Impervious Acres Treated	0.75 Acres
Potential Load Reductions TP	2.01 lbs/year
Potential Load Reductions TN	27.58 lbs/year
Potential Load Reductions TSS	4,166 lbs/year
Estimated Design/Construction Costs	$113,519 $151,764/impervious acre treated
Adjacent Projects	None

Site Description

Existing SWM000342 is an extended detention facility located behind 511 Cedar Hill Court in a residential area and is accessible from Cedar Hill Court. The facility is in the MSB-4 subwatershed. There is high grassy vegetation in and around the pond. The facility drains through a riser structure that conveys flow into a natural channel. There is standing water and wetland vegetation around the riser structure. The facility has two inflow points. The first is a 24-inch RCP with end section that conveys flow from Cedar Hill Court into the northeastern part of the facility. There is some riprap displacement at the inflow. The second consists of surface drainage from behind residences on Cedar Hill Court entering the facility from the west. There is also a corrugated 4-inch HDPE conveying flow from the property at 511 Cedar Hill Court into a 10-foot wide spillway on the northern part of the facility (Figure B-16). A 10-foot wide grass emergency spillway is on the eastern part of the facility.

Figure B-16. Facing east towards the facility with the 10-foot spillway entering from the residence (left); The surface drainage inflow point (right)

There was no rainfall observed in the area on the day of the site visit (5/22/19). No rainfall was observed during the two days prior to the field site visit. The concrete riser structure sits on the southern part of the facility. There is a 6-inch low flow PVC pipe and an 18-inch RCP with a wingwall at the outfall. There is severe outfall sediment, but the outfall is still hydrologically connected to the natural stream behind

it. There is some erosion where the outfall enters Bynum Run confluent to James Run. Flow travels southeast, under Cedar Lane, via a 60-inch wide and 44-inch high elliptical CMP culvert (Figure B-17).

Figure B-17. Looking upstream at the sediment build-up at the outfall (left): The upstream end of the elliptical CMP culvert conveying flows under Cedar Lane (right)

A portion of the extended detention facility is being recommended as a submerged gravel wetland retrofit opportunity. Generally, submerged gravel wetlands have lengths that are twice their width to promote water quality treatment. As the outlet riser structure location for the existing pond is fixed, the submerged gravel wetland is placed where most of the drainage inflow to the pond can be captured (i.e. long length), without also collecting runoff from the other inflow points that travel a shorter distance to the outlet. The drainage area listed below is the area draining from the 24-inch RCP from the northeast.

- Drainage Area: 3.05 acres
- Impervious Drainage Area: 0.68 acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the eastern portion of the current extended detention basin footprint and would capture stormwater entering through the 24-inch RCP. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom and include a forebay at the inlet.
- Proposed project plans are shown in Figure B-18.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Cedar Hill

Access

- Fair Access: Moderate slope into facility via Cedar Hill Court through gated chain-link fence. The existing facility is located on communal HOA land.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000342 are shown in Table B-12. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.41 inch of rainfall which corresponds to 1.10 impervious acre credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 0.75 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 66% for nitrogen, 77% for phosphorus, and 82% for sediment (MDE, 2014a).

Items of Note

The appearance of the retrofit would change from mown grass to wetland plantings; therefore, there may be concerns from the community about the conversion from dry pond to submerged gravel wetland. Also, since the facility is privately owned, community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $113,519 for retrofitting existing BMP-SWM000342. Project costs are broken down by cost per impervious acre treated (Table B-13). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-12: Summary of Improvements for Existing BMP-SWM000342

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000342	3.05	0.68	-	0.75	27.58	2.01	4,166
Outfall								
Stream								
Total Credit/ Reductions					0.75	27.58	2.01	4,166

Table B-13: Summary of Project Costs for Retrofitting Existing BMP-SWM0000342

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000342	$113,519	$151,764
Outfall			
Stream			
Total Costs		$113,519	$151,764

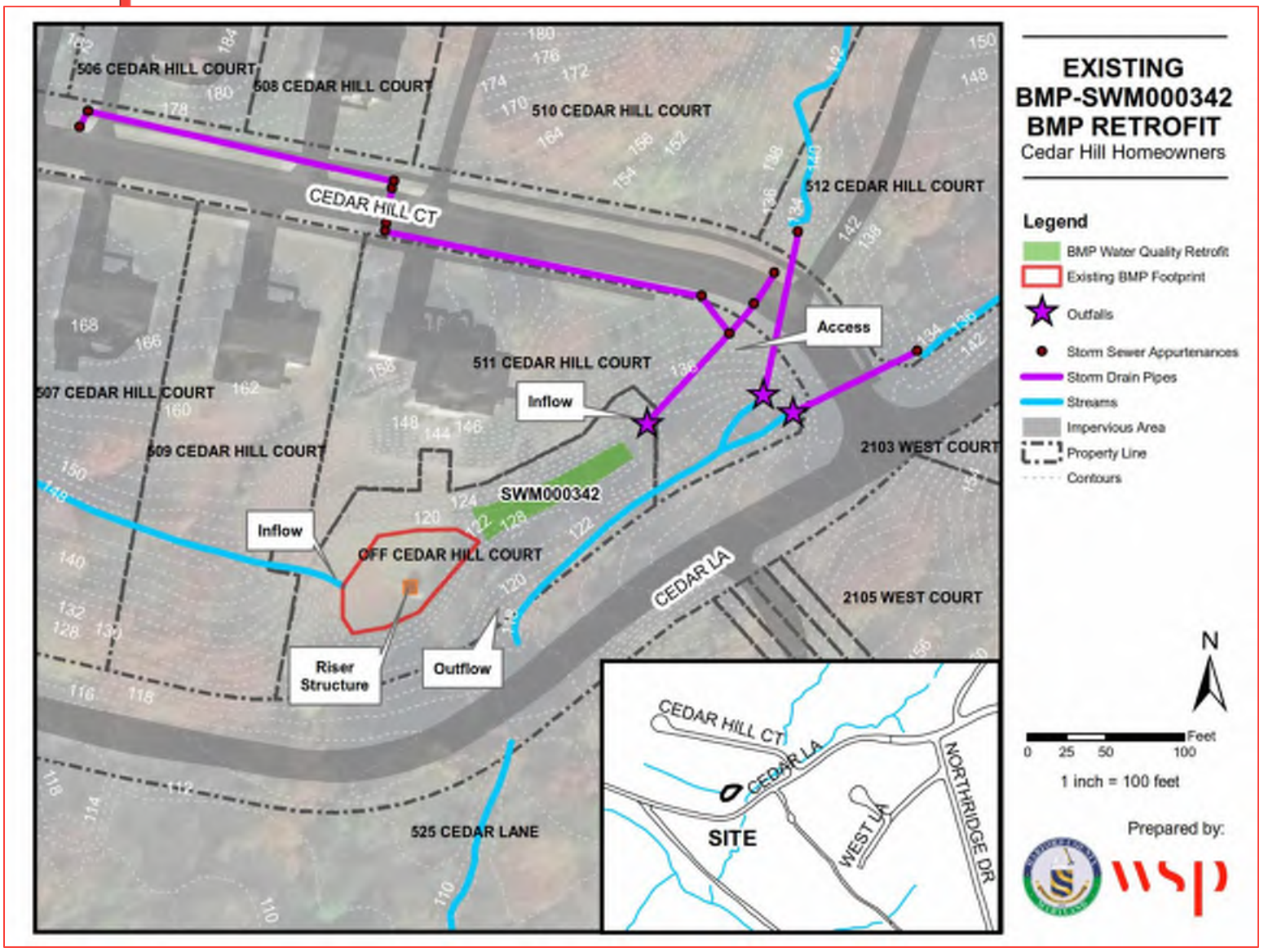

Figure B-18: Site Location and Proposed Retrofit for Existing BMP SWM000342.

RETROFIT OF EXISTING BMP-SWM000347: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of existing extended detention facility (Existing BMP-SWM000347) with a submerged gravel wetland
Location	Adjacent to the property at 3030 Clarkson Drive
Property Ownership	Tiffany Woods Community Association, Inc.
Subwatershed	MSB-3
Potential Impervious Acres Treated	2.08 Acres
Potential Load Reductions TP	47.23 lbs/year
Potential Load Reductions TN	3.08 lbs/year
Potential Load Reductions TSS	6,553 lbs/year
Estimated Design/Construction Costs	$259,395 $124,769/impervious acre treated
Adjacent Projects	SWM000415

Site Description

Existing BMP-SWM000347 is an extended detention facility located adjacent to 3030 Clarkson Drive within the MSB-3 subwatershed. One 21-inch RCP with a concrete end section conveys flows into the site from the storm drain system. Incoming flows originate from the west and are conveyed through the system under Clarkson Drive (Figure B-19). One riprap slope measuring approximately 30 feet wide conveys overland flows from the southwest. Shallow standing water and wetland vegetation were observed within the facility. A concrete riser structure controls flows out of the facility and discharges through a 24-inch RCP principal spillway. The principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the south.

Figure B-19. Facing southeast towards the facility (left); Erosion behind the 21-inch RCP inflow point (right)

Rainfall totaling 0.05-inch had been observed in the area on the day of the site visit (6/5/19). The facility is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field work), there is a low-flow 6-inch perforated PVC pipe. Overflow is conveyed through a two-sided weir with trash racks (Figure B-20).

Figure B-20. The access path from Clarkson Drive (left): The riser structure (right)

- Drainage Area: 4.58 Acres
- Impervious Drainage Area: 1.65 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the northern portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Stabilize the slope behind the 21-inch inlet.
- Proposed project plans are shown in Figure B-21.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowners Association, Tiffany Woods Community Association, Inc.

Access

- Good Access: Moderate slope into facility through gated chain-link fence. Existing facility located on communal HOA land.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000347 are shown in Table B-14. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.02 inch of rainfall which

corresponds to 1.26 impervious acre credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 2.08 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 67% for nitrogen, 78% for phosphorus, and 84% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $259,395 for retrofitting existing BMP-SWM000347. Project costs are broken down by cost per impervious acre treated (Table B-15). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-14: Summary of Improvements for Existing BMP-SWM000347

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000347	4.58	1.65	-	2.08	47.23	3.08	6,553
Outfall								
Stream								
Total Credit/ Reductions					2.08	47.23	3.08	6,553

Table B-15: Summary of Project Costs for Retrofitting Existing BMP-SWM0000347

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000347	$259,395	$124,769
Outfall			
Stream			
Total Costs		$259,395	$124,769

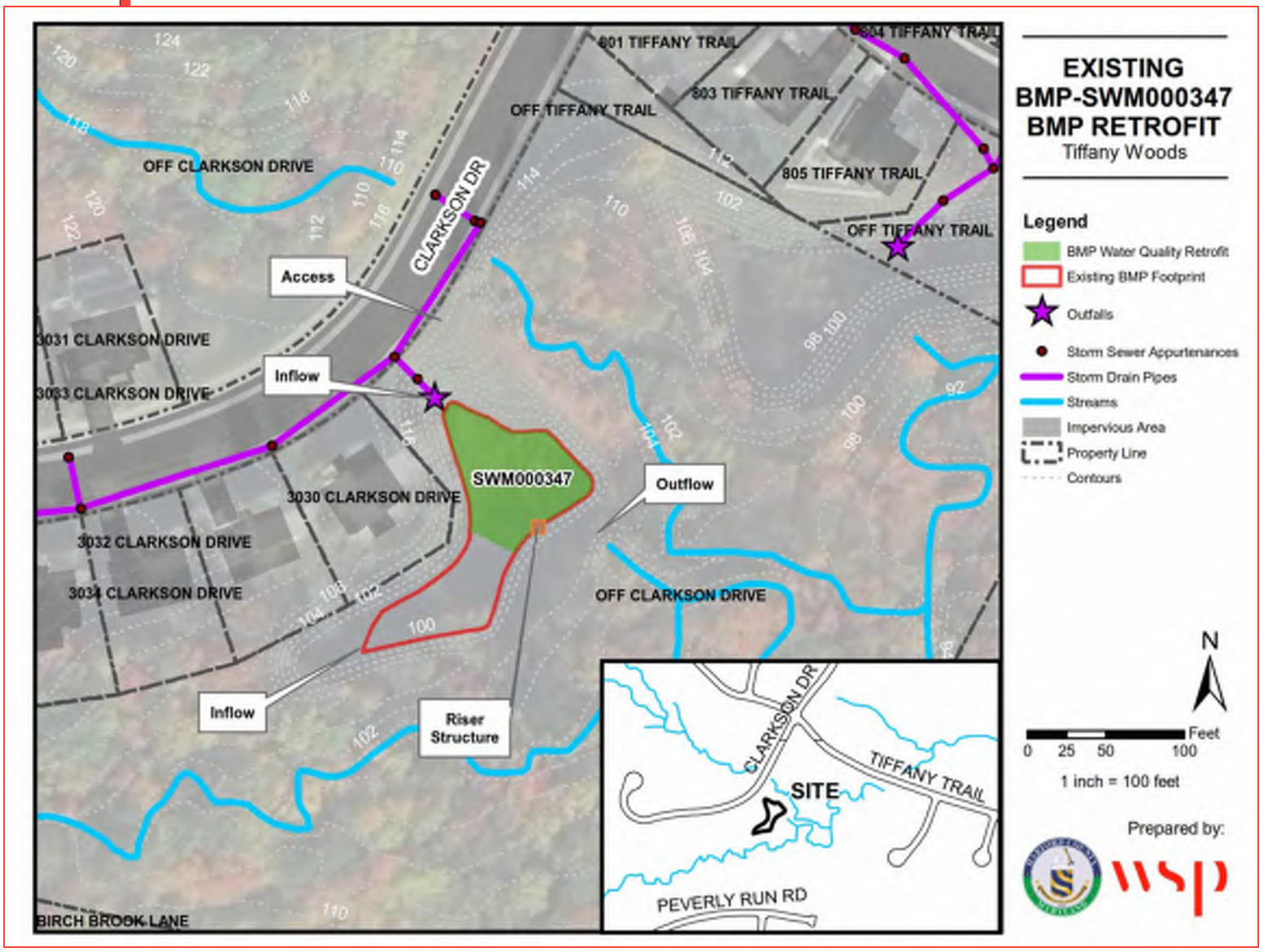

Figure B-21: Site Location and Proposed Retrofit for Existing BMP SWM000347.

RETROFIT OF EXISTING BMP-SWM000415: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000415) with a submerged gravel wetland
Location	Behind the property at 805 Tiffany Trail
Property Ownership	Tiffany Woods Community Association, Inc.
Subwatershed	MSB-3
Potential Impervious Acres Treated	3.84 Acres
Potential Load Reductions TP	102.63 lbs/year
Potential Load Reductions TN	6.80 lbs/year
Potential Load Reductions TSS	14,373 lbs/year
Estimated Design/Construction Costs	$300,984 $78,479/impervious acres treated
Adjacent Projects	SWM000347

Site Description

Existing SWM000415 is an extended detention facility located behind the property at 805 Tiffany Trail. It is fenced and accessible via a chain link swing gate located directly off Tiffany Trail. It is within the MSB-3 subwatershed. One 36-inch RCP conveys flows originating from the storm sewer system from the northeast into the facility. One riprap slope at the northwest corner of the facility conveys overland flows from the northwest. There is a concrete riser structure with a 36-inch CMP principal spillway. A riprap apron at the principal spillway outfall drains to a channel discharging to an unnamed tributary to Bynum Run to the south. Shallow standing water and wetland vegetation were observed within the facility (Figure B-22).

Figure B-22. Facing west towards the facility from Tiffany Trail (left): The embankment behind the riser structure (right)

Rainfall totaling 0.05-inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition. Based on record drawings (and confirmed during field work), there is an 8-inch low flow CMP in the riser structure. Overflow is conveyed through a trash racks along the front face and two sides of the riser (Figure B-23).

Figure B-23. Access gate from Tiffany Trail (left); The outfall and outfall channel (right)

- Drainage Area: 11.00 Acres
- Impervious Drainage Area: 3.76 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within a portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. A berm is needed to extend the time stormwater is in the facility. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-24.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Tiffany Woods Community Association, Inc.

Access

- Good Access: Access from Tiffany Trail.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000415 are shown in Table B-16. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.07 inches of rainfall which corresponds to 1.02 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 3.84 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 61% for nitrogen, 72% for phosphorus, and 77% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $300,984 for retrofitting existing BMP-SWM000415. Project costs are broken down by cost per impervious acre treated (Table B-17). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-16: Summary of Improvements for Existing BMP SWM000415

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000415	11.00	3.76	-	3.84	102.63	6.80	14,373
Outfall								
Stream								
Total Credit/ Reductions					3.84	102.63	6.80	14,373

Table B-17: Summary of Project Costs for Retrofitting Existing BMP SWM000415

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000415	$300,984	$78,479
Outfall			
Stream			
Total Costs		$300,984	$78,479

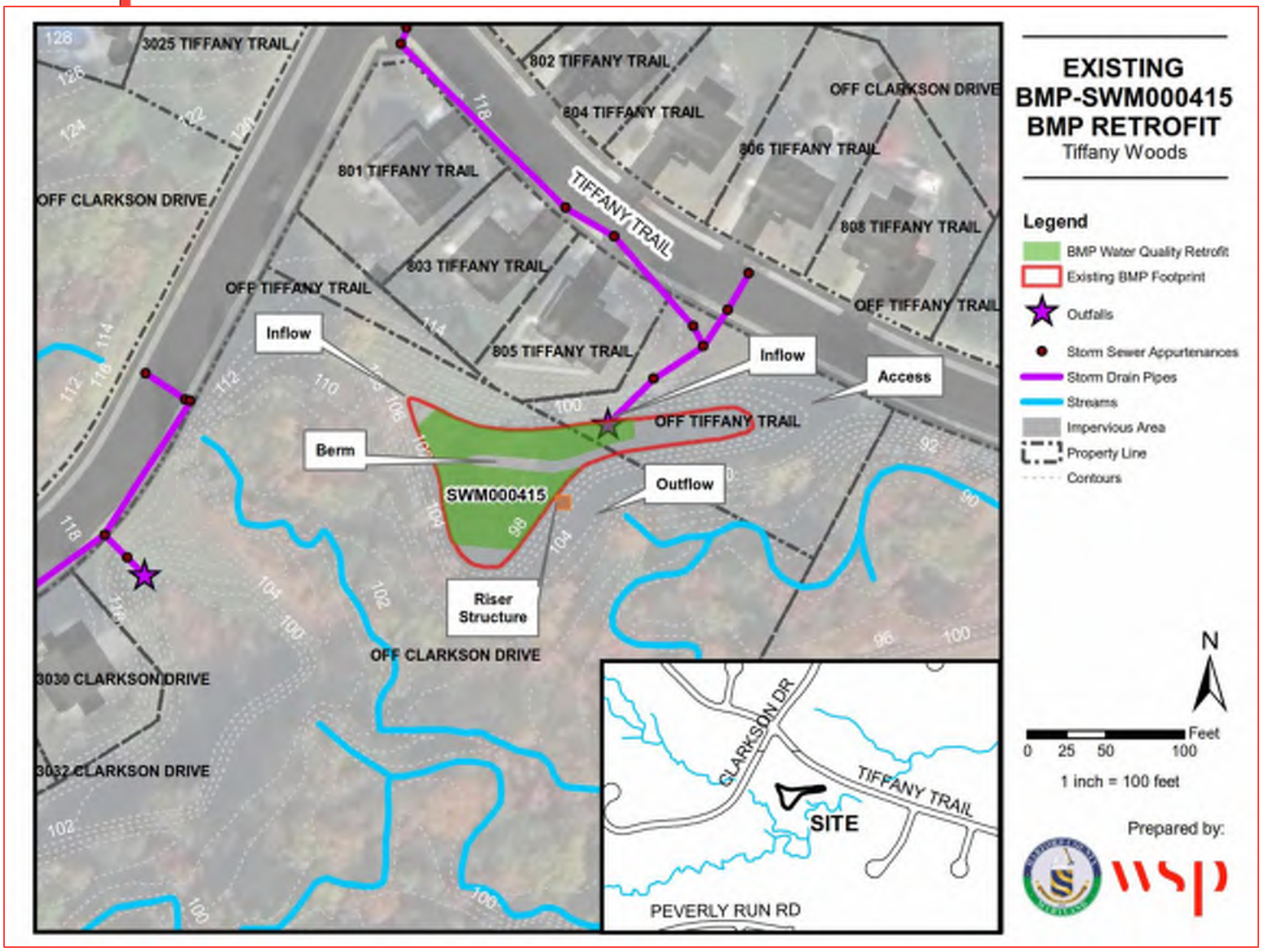

Figure B-24. Site Location and Proposed Retrofit for Existing BMP-SWM000415

RETROFIT OF EXISTING BMP-SWM000428: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000428) with a submerged gravel wetland
Location	Behind the property at 3139 Birch Brook Lane
Property Ownership	Woodland Run
Subwatershed	MSB-3
Potential Impervious Acres Treated	2.05 Acres
Potential Load Reductions TP	58.31 lbs/year
Potential Load Reductions TN	4.12 lbs/year
Potential Load Reductions TSS	8,632 lbs/year
Estimated Design/Construction Costs	$288,689 $141,099/impervious acres treated
Adjacent Projects	None

Site Description

Existing SWM000428 is an extended detention facility located behind the residence at 3139 Birch Brook Lane. It is accessible from Birch Brook Lane between 3139 Birch Brook Land and 3137 Birch Brook Lane. It is fenced with unobstructed access to an 18-foot swing gate. The facility is within the MSB-3 subwatershed. A 24-inch RCP conveys flows from residences along Birch Brook Lane into the northeast part of the facility. Another inflow point is an 8-foot gabion reinforced slope in the southwest corner of the facility (Figure B-25). Two 4-inch HDPE residential drains convey flows to the top of this slope. This area of the facility has moderate erosion. There is a 4-inch HDPE residential drain into the southeast corner of the facility.

Figure B-25. The 24-inch RCP and facility from access path (left): Southwest corner of facility (right)

There was 0.41-inch of rainfall observed in the area on the day of the site visit (7/17/19). There were 0.02-inch of rainfall in the area on the two days prior to the site visit. A 36-inch diameter cylindrical CMP riser structure sits on the northern border of the facility. Low flows enter through a 24-inch CMP and discharge through a 24-inch CMP principal spillway. The end section of the principal spillway is rusted out. The outfall channel acts as the head of a natural channel. A 5-foot headcut exists 16 feet downstream of the outfall. The channel downstream has 5 to 6 feet of erosion on its banks (Figure B-26).

Figure B-26. The outfall and end section (left); Upstream at outfall channel erosion – headcut visible in upper left corner (right)

- Drainage Area: 6.09 Acres
- Impervious Drainage Area: 1.55 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within the current extended detention basin footprint. A berm is needed to extend the time stormwater is in the facility. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Repair slope where the 4-inch HDPE residential pipes are located.
- Proposed project plans are shown in Figure B-27.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Woodland Run

Access

- Good Access: Access from ROW between two residences.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000428 are shown in Table B-18. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.26 inches of rainfall which corresponds to 1.32 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 2.05 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 68% for nitrogen, 79% for phosphorus, and 85% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $288,689 for retrofitting existing BMP-SWM000428. Project costs are broken down by cost per impervious acre treated (Table B-19). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-18: Summary of Improvements for Existing BMP SWM000428

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000428	6.09	1.55	-	2.05	58.31	4.12	8,632
Outfall								
Stream								
Total Credit/ Reductions					2.05	58.31	4.12	8,632

Table B-19: Summary of Project Costs for Retrofitting Existing BMP SWM000428

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000428	$288,689	$141,099
Outfall			
Stream			
Total Costs		$288,689	$141,099

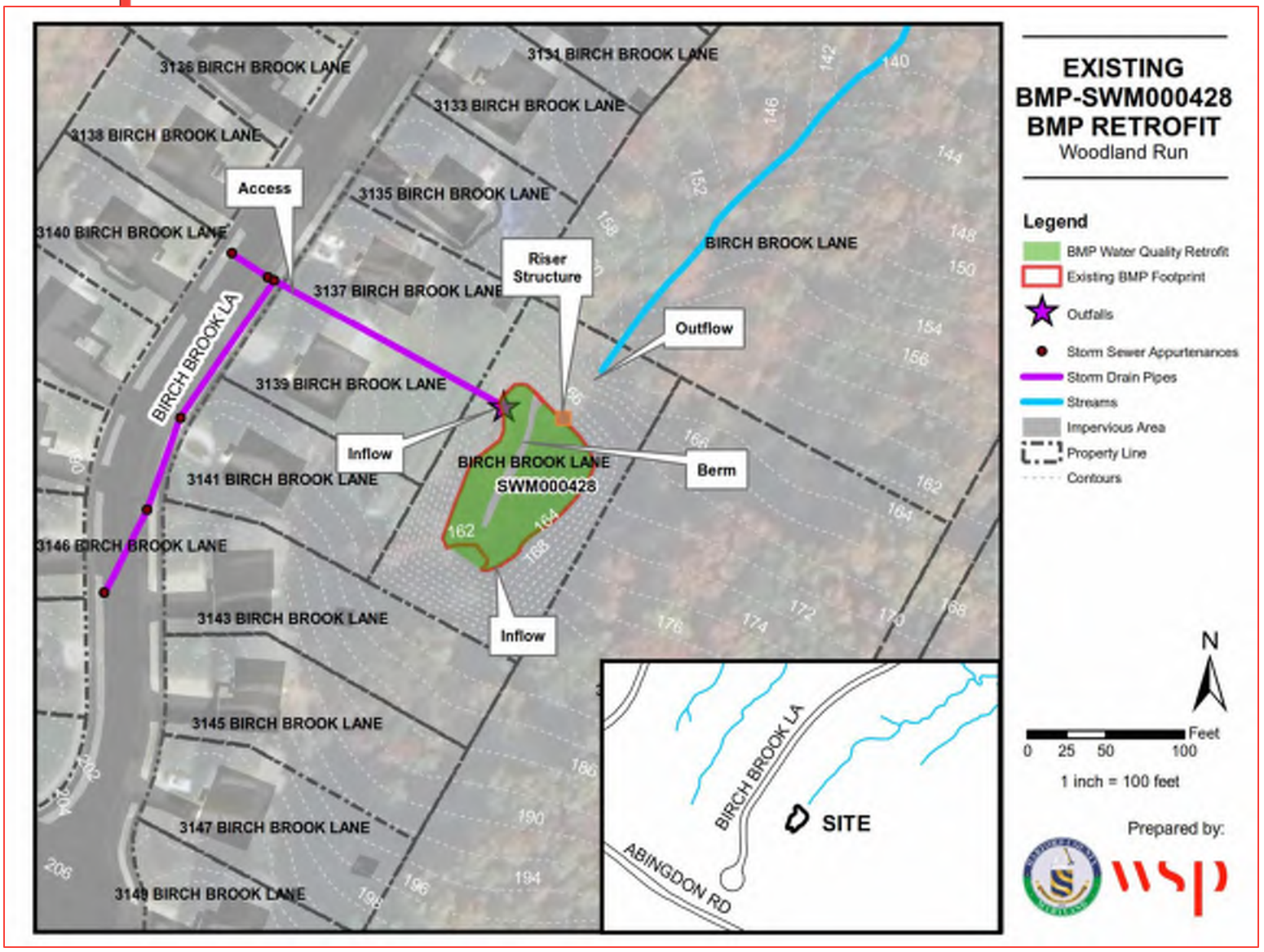

Figure B-27. Site Location and Proposed Retrofit for Existing BMP-SWM000428

RETROFIT OF EXISTING BMP-SWM000472: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of the existing extended detention facility (Existing BMP-SWM000472) with a submerged gravel wetland
Location	Behind the property at 1219 Lobo Court
Property Ownership	Cokesbury Manor Community
Subwatershed	MSB-2
Potential Impervious Acres Treated	4.37 Acres
Potential Load Reductions TP	112.65 lbs/year
Potential Load Reductions TN	7.76 lbs/year
Potential Load Reductions TSS	16,330 lbs/year
Estimated Design/Construction Costs	$511,508 $117,071/impervious acres treated
Adjacent Projects	SWM000683, MSB-2A Stream Restoration

Site Description

Existing SWM000472 is an extended detention facility located northeast of Lobo Court. It is accessible from Lobo Court between 1219 Lobo Court and 1220 Lobo Court. The facility is within the MSB-2 subwatershed. One 36-inch CMP into the facility conveys flows originating from the storm sewer system to the east and south. The facility also receives runoff along a grass slope to the south. There is a concrete riser structure with a 24-inch RCP principal spillway. The principal spillway drains to a channel discharging to Bynum Run to the north. Overflows drain to a 40-foot grass emergency spillway along the southwest corner. No standing water or wetland vegetation were noted (Figure B-28).

Figure B-28. The riser structure behind the 36-inch CMP inflow pipe (left); The embankment behind riser structure (right)

No precipitation had been observed in the area on the day of the site visit (6/7/19). Rainfall totaling 0.07-inch was observed during the two days prior to the field site visit. The pond is functioning as a dry pond in its current condition (Figure B-29). Based on record drawings (and confirmed during field observations), there is a 5-inch low flow RCP orifice with a trash rack. Note that the 24-inch principal spillway is currently smaller than the 36-inch inflow pipe.

Figure B-29. Access path from Lobo Court (left); Western border of facility and emergency spillway in the background (right)

- Drainage Area: 11.48 Acres
- Impervious Drainage Area: 3.31 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within a portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-30.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Cokesbury Manor

Access

- Good Access: Access from ROW between two residences.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000472 are shown in Table B-20. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.26 inches of rainfall which corresponds to 1.32 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 4.37 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 67% for nitrogen, 79% for phosphorus, and 85% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $511,508 for retrofitting existing BMP-SWM000472. Project costs are broken down by cost per impervious acre treated (Table B-21). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-20: Summary of Improvements for Existing BMP SWM000472

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000472	11.48	3.31	-	4.37	112.65	7.76	16,330
Outfall								
Stream								
Total Credit/ Reductions					4.37	112.65	7.76	16,330

Table B-21: Summary of Project Costs for Retrofitting Existing BMP SWM000472

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000472	$511,508	$117,071
Outfall			
Stream			
Total Costs		$511,508	$117,071

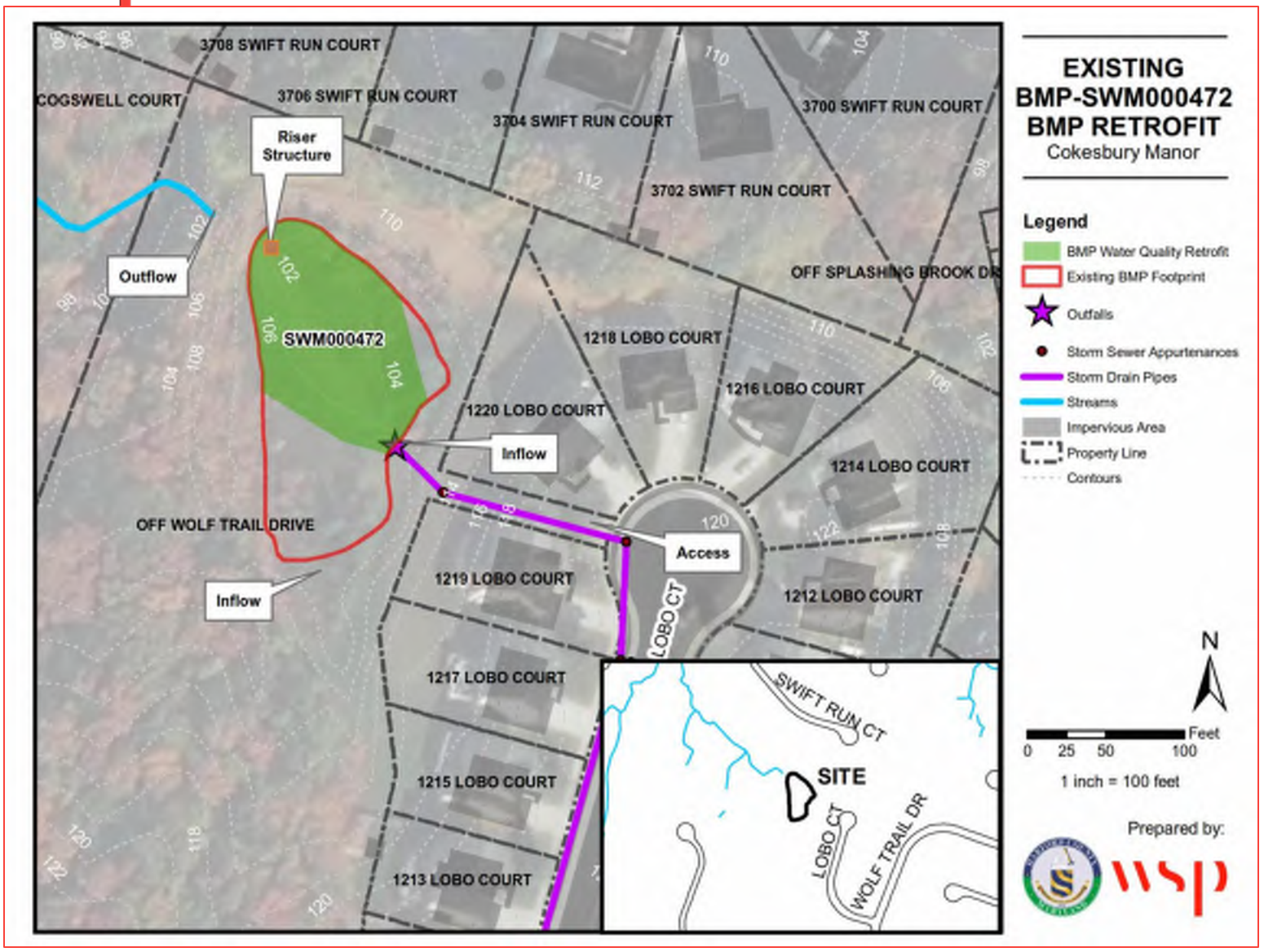

Figure B-30. Site Location and Proposed Retrofit for Existing BMP-SWM000472

RETROFIT OF EXISTING BMP-SWM000622: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit a portion of existing extended detention facility (Existing BMP-SWM000622) with a submerged gravel wetland
Location	Behind the property at 720 Hookers Mill Road
Property Ownership	Woodlands Homeowners Association
Subwatershed	MSB-3
Potential Impervious Acres Treated	0.42 Acres
Potential Load Reductions TP	21.09 lbs/year
Potential Load Reductions TN	1.67 lbs/year
Potential Load Reductions TSS	3,415 lbs/year
Estimated Design/Construction Costs	$80,864 $193,224/impervious acres treated
Adjacent Projects	None

Site Description

Existing SWM000622 is an extended detention facility located off Hookers Mill Road, behind residences including 720 Hookers Mill Road. It is accessible from a 12-foot wide access driveway off the road. It is fenced and has an 18-foot swing gate. The facility is within the MSB-3 subwatershed. A 15-inch HDPE pipe conveys flows into the eastern part of the facility. The inflow has severe sediment build-up that may hinder flows during high flow events. Most of the fencing around the facility needs repair (Figure B-31).

Figure B-31. Clogged inflow pipe (left); Broken fence behind inflow pipe (right)

There was no rainfall observed in the area on the day of the site visit (5/29/19). There was 0.09-inch of rainfall in the area on the two days prior to the site visit. There is no riser structure on the facility. There is a 6-inch plated PVC principal spillway for low flows and a 12-inch wide concrete weir for high flows. A 19-foot wide by 17-foot long riprap outfall protection exists at the outfall where flows dissipate into an open field downstream (Figure B-32). The immediate outfall area extending to approximately 100-feet downstream is in good condition but may need channel protection if flows increase.

Figure B-32. Concrete weir and outfall channel (left); Facility from northern corner (right)

- Drainage Area: 2.46 Acres
- Impervious Drainage Area: 0.31 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within a portion of the current extended detention basin footprint to capture the maximum amount of inflow and meet design requirements. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Repair and unclog the 15-inch HDPE inflow pipe.
- Proposed project plans are shown in Figure B-33.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Woodlands Homeowners Association

Access

- Good Access: Access from ROW between a residence and the natural stream.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000622 are shown in Table B-22. The table includes the drainage area of each improvement, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.60 inches of rainfall which corresponds to 1.40 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 0.42 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 68% for nitrogen, 79% for phosphorus, and 85% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $80,864 for retrofitting existing BMP-SWM000622. Project costs are broken down by cost per impervious acre treated (Table B-23). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-22: Summary of Improvements for Existing BMP SWM000622

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000622	2.46	0.31	-	0.42	21.09	1.67	3,415
Outfall								
Stream								
Total Credit/ Reductions					0.42	21.09	1.67	3,415

Table B-23: Summary of Project Costs for Retrofitting Existing BMP SWM000622

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000622	$80,864	$193,224
Outfall			
Stream			
Total Costs		$80,864	$193,224

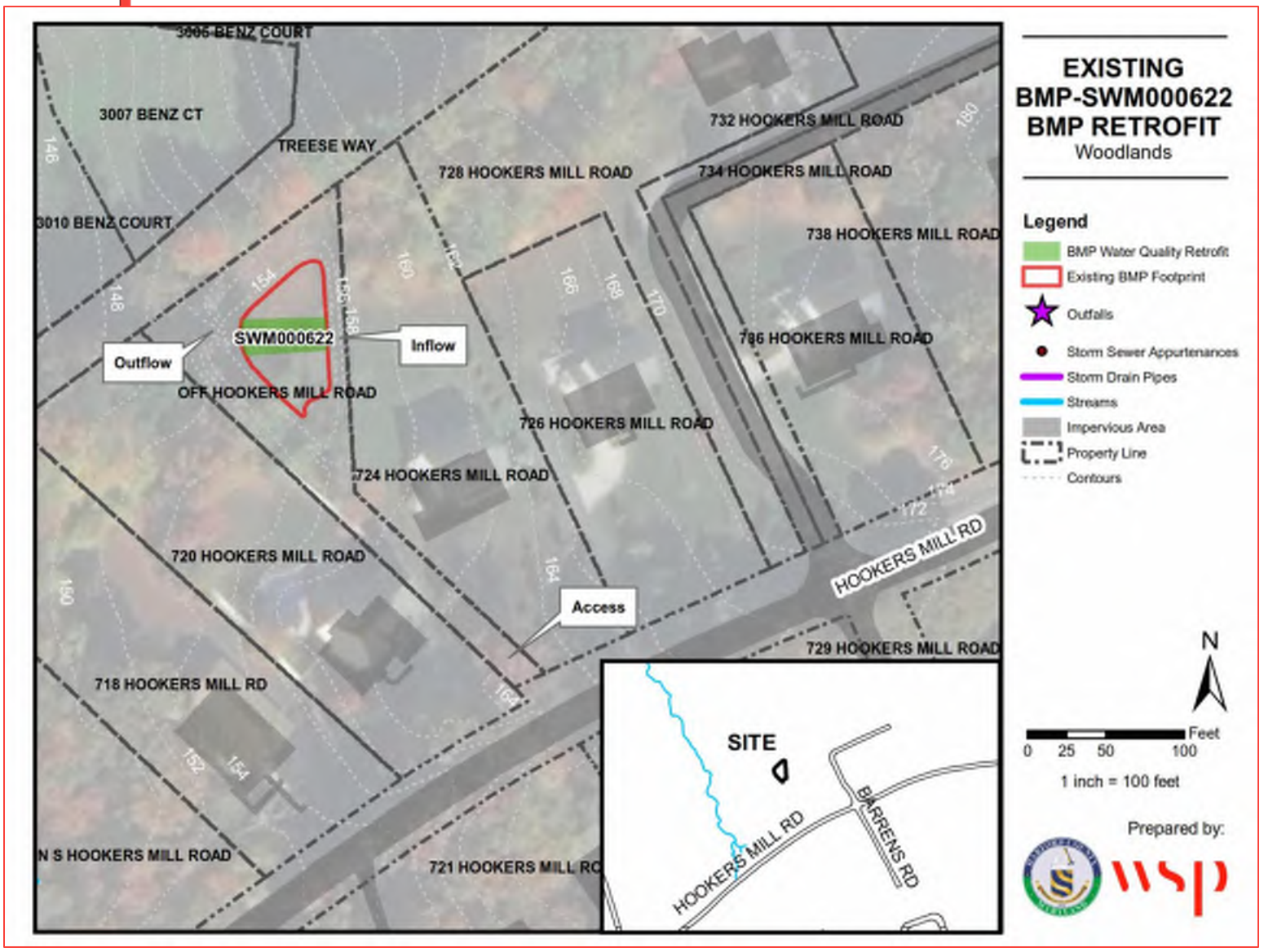

Figure B-33. Site Location and Proposed Retrofit for Existing BMP-SWM000622

RETROFIT OF EXISTING BMP-SWM000683: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000683) with a submerged gravel wetland
Location	Adjacent to the property at 1300 Hidden Brook Court
Property Ownership	Abingdon Estates
Subwatershed	MSB-2
Potential Impervious Acres Treated	1.51 Acres
Potential Load Reductions TP	34.83 lbs/year
Potential Load Reductions TN	2.30 lbs/year
Potential Load Reductions TSS	4,877 lbs/year
Estimated Design/Construction Costs	$208,985 $138,364/impervious acres treated
Adjacent Projects	SWM000472, MSB-2A Stream Restoration

Site Description

Existing SWM000683 is an extended detention facility located off Hidden Brook Court adjacent to residences including 1300 Hidden Brook Court and 1302 Hidden Brook Court. It is accessible from the Homeowners Association property between the residences noted above and is within the MSB-2 subwatershed. One 18-inch CMP into the facility conveys flows originating from the storm sewer system to the west. One 15-inch CMP into the facility conveys flows originating from the storm sewer system to the north. There is a CMP riser structure with an 18-inch CMP principal spillway. The principal spillway drains to a channel ultimately discharging to Bynum Run to the north. The slope spanning approximately 5 feet downstream of the spillway to the confluence with the existing natural channel is severely eroded. Undercutting, vertical bank incision of 5 to 10 feet, and various downed large diameter trees were observed along the eroded slope. There is a 20-foot grass emergency spillway at the southeast corner of the pond. No standing water or wetland vegetation were observed within the facility (Figure B-34).

Figure B-34. Access gate from Hidden Brook Court (left); Emergency spillway and riprap inflow point (right)

Precipitation totaling 0.05-inch had been observed in the area on the day of the site visit (6/5/19). No rainfall was observed during the two days prior to the field site visit. The pond is functioning as a dry

pond in its current condition. Based on record drawings, there is a 6-inch CMP low flow orifice. High flows enter the CMP riser structure (Figure B-35).

Figure B-35. Embankment behind riser structure and 15-inch CMP inflow pipe (left); Eroded outfall channel (right)

- Drainage Area: 3.41 Acres
- Impervious Drainage Area: 1.18 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended within a portion of the current extended detention basin footprint. The submerged gravel wetland would have a forebay at each inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-36.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Abingdon Estates

Access

- Good Access: Access from Hidden Brook Court.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000683 are shown in Table B-24. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 2.13 inches of rainfall which corresponds to 1.28 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 1.51 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 67% for nitrogen, 78% for phosphorus, and 84% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $208,985 for retrofitting existing BMP-SWM000683. Project costs are broken down by cost per impervious acre treated (Table B-25). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-24: Summary of Improvements for Existing BMP SWM000683

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000683	3.41	1.18	-	1.51	34.83	2.30	4,877
Outfall								
Stream								
Total Credit/ Reductions					1.51	34.83	2.30	4,877

Table B-25: Summary of Project Costs for Retrofitting Existing BMP SWM000683

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000683	$208,985	$138,364
Outfall			
Stream			
Total Costs		$208,985	$138,364

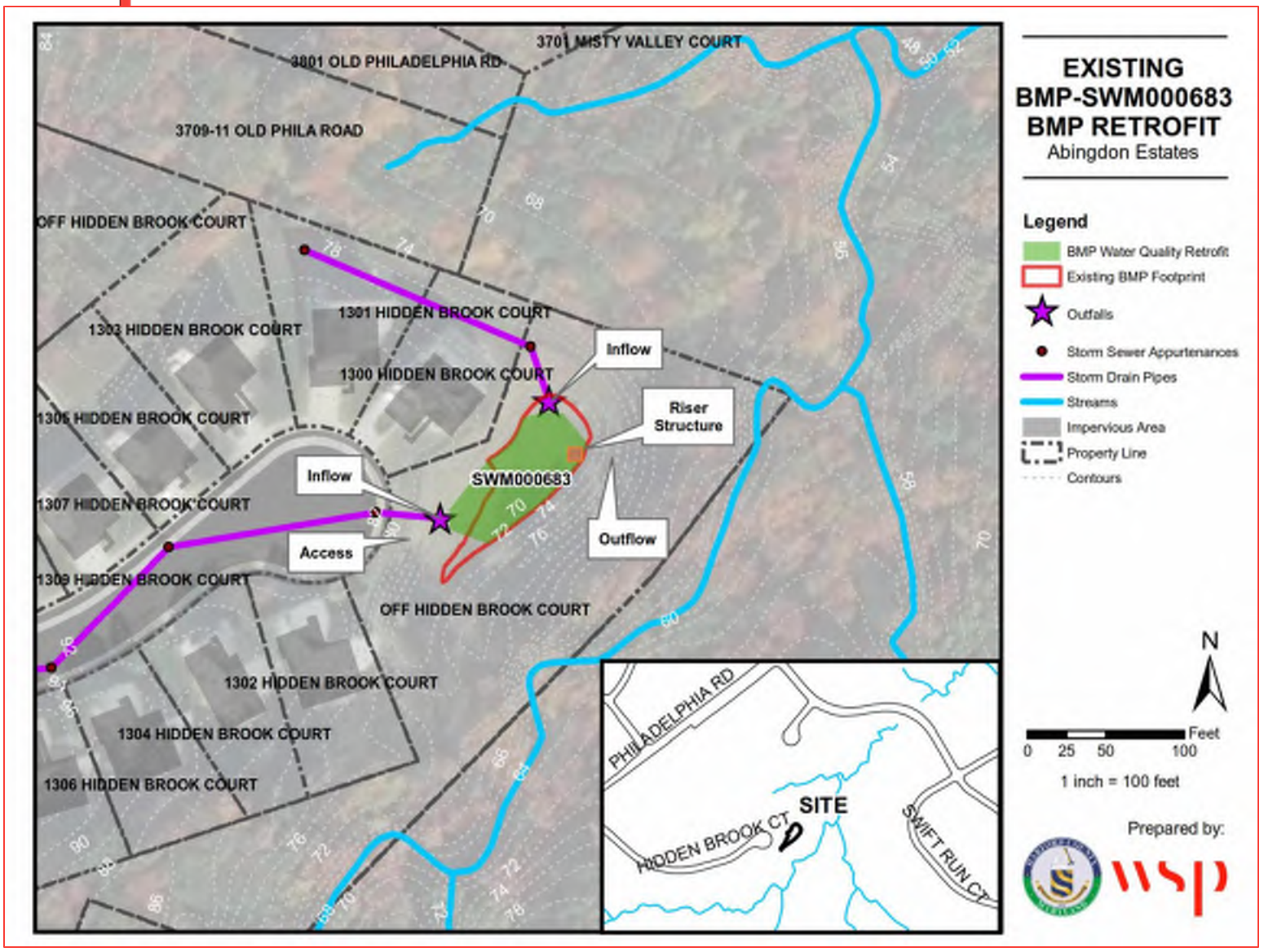

Figure B-36. Site Location and Proposed Retrofit for Existing BMP-SWM000683

RETROFIT OF EXISTING BMP-SWM000685: SUBMERGED GRAVEL WETLAND

Project Description	Retrofit existing extended detention facility (Existing BMP-SWM000685) with a submerged gravel wetland
Location	Behind the property at 1306 Forest Oak Court
Property Ownership	Stone Ridge
Subwatershed	LB-1
Potential Impervious Acres Treated	4.52 Acres
Potential Load Reductions TP	139.04 lbs/year
Potential Load Reductions TN	9.76 lbs/year
Potential Load Reductions TSS	20,395 lbs/year
Estimated Design/Construction Costs	$450,193 $99,611/impervious acres treated
Adjacent Projects	None

Site Description

Existing SWM000685 is an extended detention facility located on the south end of Forest Oak Court, behind the residence at 1306 Forest Oak Court. It is accessible between 1306 Forest Oak Court and 1307 Forest Oak Court. The site has a painted wooden fence and gate. A resident is concerned about a damaged portion of the fence on the northwestern border. The facility is within the LB-1 subwatershed. A 36-inch RCP conveys flows from residences along Stone Ivy Place, Briar Post Court, and Forest Oak Court into the facility. Flows enter a forebay with minor riprap displacement. A 23-foot grass emergency spillway exists at the southern end of the facility. There is wetland vegetation, but no standing water, in the pond (Figure B-37).

Figure B-37. Facility from behind riser structure (left); Western part of the facility from access path via Forest Oak Court (right)

There was no rainfall observed in the area on the day of the site visit (5/9/19). No rainfall was observed during the two days prior to the field site visit. There is concrete riser structure at the east part of the facility with weir openings on all sides. The riser has a 12-inch low flow CMP orifice, an 8-inch high flow PVC pipe orifice, and a 30-inch RCP principal spillway where flows enter an unnamed tributary to Bynum

Run. There is minor riprap displacement at the outfall. There are minor outfall issues extending to approximately 100 feet downstream (Figure B-38).

Figure B-38. The embankment behind the riser structure (left); Facing upstream at the outfall and outfall protection (right)

- Drainage Area: 14.67 Acres
- Impervious Drainage Area: 3.93 Acres

Recommended Restoration Actions

- To improve water quality, a submerged gravel wetland retrofit is recommended the current extended detention basin footprint. A berm is needed to extend the time stormwater is in the facility. The submerged gravel wetland would have a forebay at the inflow and would be excavated down from the existing detention basin bottom.
- Proposed project plans are shown in Figure B-39.

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Homeowner Association, Stone Ridge

Access

- Good Access: Access from ROW between two residences.

Summary of Restoration Improvements

A summary of improvements for retrofitting existing BMP-SWM000685 are shown in Table B-26. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed submerged gravel wetland treats 1.59 inches of rainfall

which corresponds to 1.15 impervious acres credit per acre of watershed impervious area. This proposed submerged gravel wetland would provide 4.52 impervious acres of treatment.

While the existing BMP does manage stormwater, the proposed submerged gravel wetland retrofit will also target water quality. Submerged gravel wetlands provide a pollutant load reduction of 66% for nitrogen, 77% for phosphorus, and 83% for sediment (MDE, 2014a).

Items of Note

Even though the retrofit is in a highly residential area, the appearance of the retrofit would be similar to current conditions; therefore, it is unlikely there will be concerns from the community about the conversion from dry pond to submerged gravel wetland. Community outreach/buy in should be obtained early in the project to ensure success.

Retrofits assume that by using the Embankment Retrofit Design guidance (MDE, 2015), the existing Maryland pond 378 dam classification of the facility will not be impacted.

Project Costs

Total project costs are $450,193 for retrofitting existing BMP-SWM000685. Project costs are broken down by cost per impervious acre treated (Table B-27). To calculate the construction cost, the average material costs of BMP components were summed along with a percent contingency. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-26: Summary of Improvements for Existing BMP SWM000685

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	SWM000685	14.67	3.93	-	4.52	139.04	9.76	20,395
Outfall								
Stream								
Total Credit/ Reductions					4.52	139.04	9.76	20,395

Table B-27: Summary of Project Costs for Retrofitting Existing BMP SWM000685

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	SWM000685	$450,193	$99,611
Outfall			
Stream			
Total Costs		$450,193	$99,611

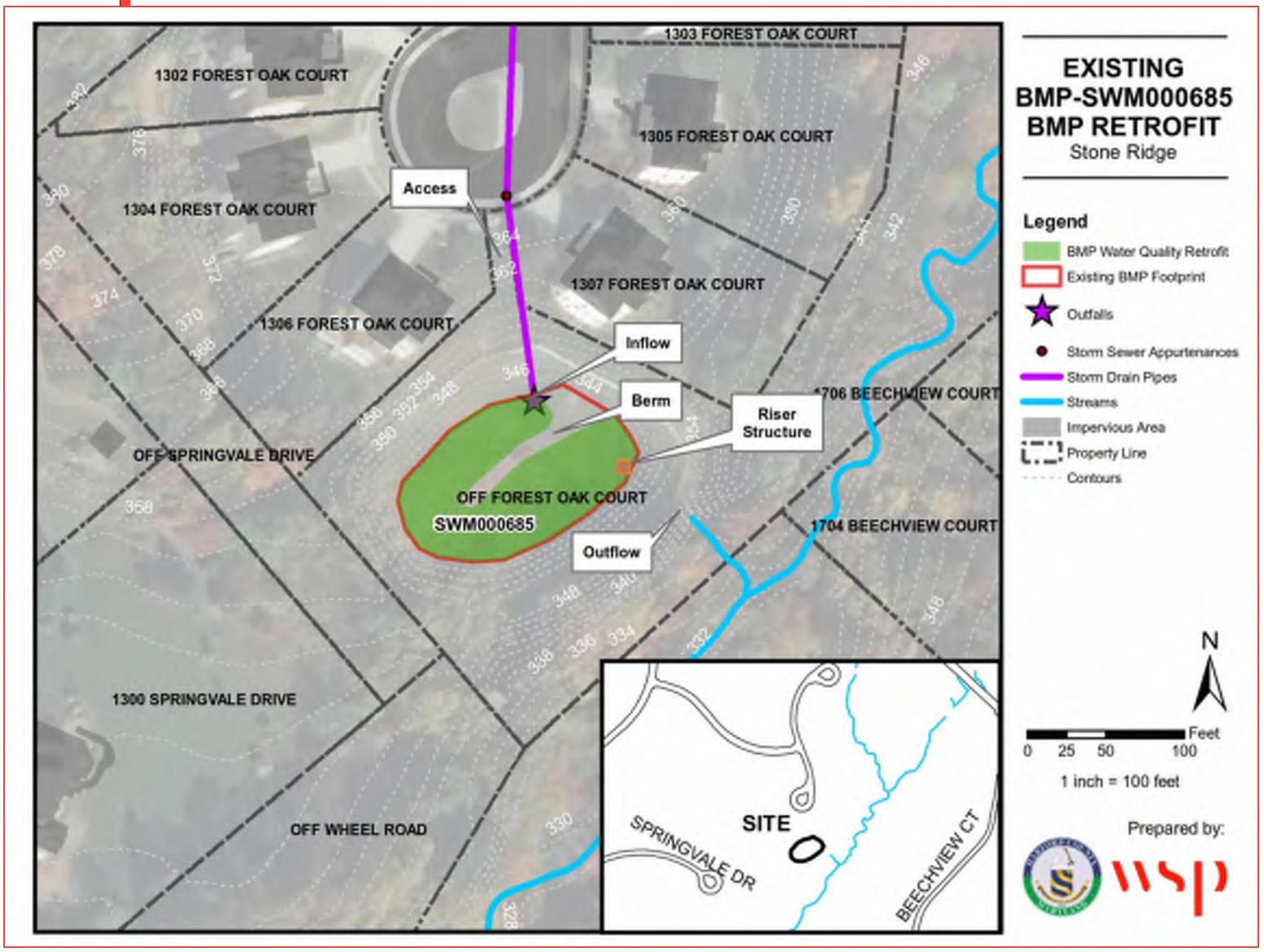

Figure B-39. Site Location and Proposed Retrofit for Existing BMP-SWM000685

B.2 PROPOSED BMP PROJECTS

A desktop evaluation of the watershed and an evaluation of previous studies within the watershed identified 2 potential new BMP projects within the watershed. As a result of the initial screening of sites during the assessment, a total of 5 of the 14 sites were identified for an in-depth field assessment. The field assessment identified 2 sites with adequate space, accessibility, and limited constructability constraints. The two proposed BMP projects are described in detail in this section. Chapter 4 provides background information on the field identification process.

PROPOSED BMP-P-4: BIORETENTION

Project Description	Bioretention
Location	Maryland Golf and Country Club 1335 East MacPhail Road
Property Ownership	Maryland Country Club, Inc.
Subwatershed	MSB-5
Potential Impervious Acres Treated	0.71 Acres
Potential Load Reductions TP	12.29 lbs/year
Potential Load Reductions TN	0.73 lbs/year
Potential Load Reductions TSS	1,591 lbs/year
Estimated Design/Construction Costs	$150,394 $212,661/impervious acres treated
Adjacent Projects	MSB-5C Stream and Outfall Restoration

Site Description

The Maryland Golf and Country Club is located near the intersection of East Macphail Road and Old Macphail Drive within the MSB-5 subwatershed. Under current conditions, a portion of the pool area and lower parking lot sheet flows to a grassy area adjacent to the lower parking lot (Figure B-40) prior to discharging into an existing stream in the woods. Additionally, there are two 12-inch RCP outfall pipes located near the proposed BMP that are heavily damaged. Both pipes are separated/broken at the joints and undermined approximately 3 feet (Figure B-41). The downstream outfall channel is significantly eroded. Approximately 1.08 acres of drainage area with 0.52 acres of impervious area drain to the existing grassy area adjacent to the parking lot.

Figure B-40: Existing grass area adjacent to parking lot – facing North (left); Existing lower parking lot – facing South (right)

Figure B-41: Heavily damaged outfall prior to discharge into stream

Recommended Restoration Actions

- A bioretention facility is proposed in the flat area adjacent to the lower parking lot near the pool to treat impervious area runoff (Figure B-42). Most soils in the area are hydrologic soil type A, indicating high infiltration rates. An underdrain is not recommended to convey treated runoff that does not infiltrate into the ground to the nearby stream. The two 12-inch RCP outfalls are inaccurately shown on the aerial. The proposed BMP will be located on top of the pipes.
- The proposed bioretention has the potential to treat 0.71 impervious acres.
- Proposed BMP plans are shown in Figure B-43.

Figure B-42: West view of proposed bioretention location (left); East view of proposed bioretention location (right)

Threats to Infrastructure

- There is no critical infrastructure in the project limits.

Property Ownership

- Private: Maryland Country Club, Inc.

Access

- Minor Access: Existing facility located on private land. Mature trees near vicinity of proposed BMP footprint.

Summary of Restoration Improvements

A summary of improvements for the proposed bioretention facility are shown in Table B-30. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed bioretention facility treats 2.60 inches of rainfall which corresponds to 2.60 impervious acre credit per acre of watershed impervious area. This proposed bioretention facility would provide a total of 0.71 impervious acres of treatment. This bioretention facility would provide a pollutant load reduction of 68% for nitrogen, 79% for phosphorus, and 85% for sediment (Schueler, 2015).

Items of Note

The responsibility of maintenance and routine inspection of the bioretention facility will need to be established with the property owner. Harford County should consider taking of maintenance responsibilities in order to ensure credit into perpetuity.

Project Costs

Total project costs are $150,394 for the proposed bioretention. Project costs are broken down by cost per impervious acre treated (Table B-29). BMP construction costs were based on actual Maryland bioretention construction costs and engineering judgement. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-28: Summary of Improvements for Proposed BMP-P-4

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	BMP-P-4 (Bioretention)	1.08	0.52	-	0.71	12.29	0.73	1,591
Outfall								
Stream								
Total Credit/ Reductions					0.71	12.29	0.73	1,591

Table B-29: Summary of Project Costs for Proposed BMP-P-4

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	BMP-P-4	$150,394	$212,661
Outfall			
Stream			
Total Costs		$150,394	$212,661

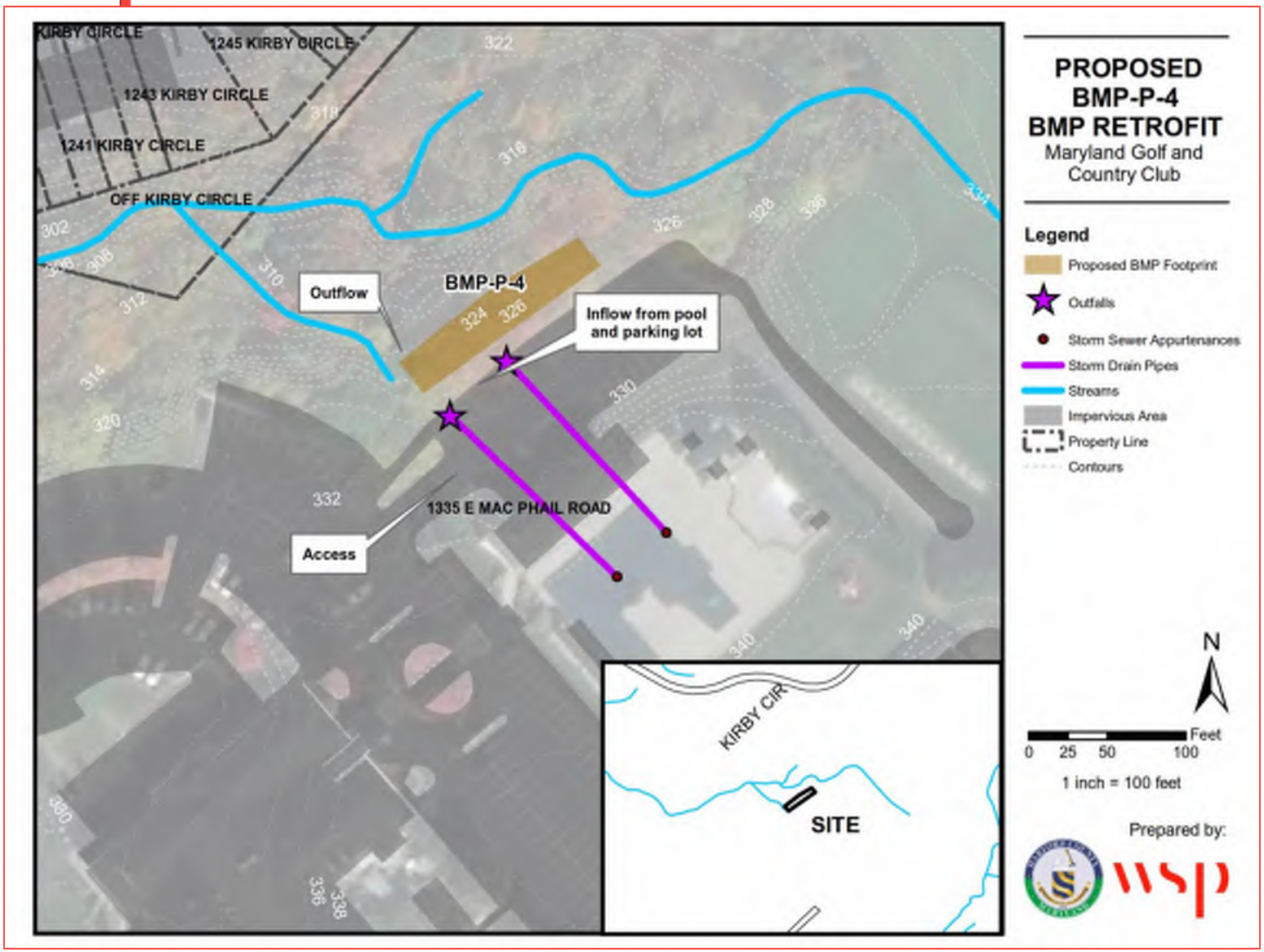

Figure B-43: Proposed BMP-P-4 Site Location

PROPOSED BMP-P-7: BIORETENTION

Project Description	Bioretention
Location	Emmorton Recreation Office 2213 Old Emmorton Road
Property Ownership	Harford County
Subwatershed	MSB-4
Potential Impervious Acres Treated	1.37 Acres
Potential Load Reductions TP	22.93 lbs/year
Potential Load Reductions TN	1.21 lbs/year
Potential Load Reductions TSS	2,699 lbs/year
Estimated Design/Construction Costs	$165,384 $121,001/impervious acres treated
Adjacent Projects	None

Site Description

Emmorton Recreation Office is located at near the intersection of Emmorton Rd. and Laurel Bush Rd. within the MSB-4 subwatershed. Under current conditions, a portion of the rooftop of Emmorton Recreation Office and the parking lot drains through an existing storm drain system prior to discharging to an adjacent stream next to Emmorton Recreation Office (Figure B-44). The rooftop drains through gutters to downspouts directly connected to the existing storm drain system. The parking lot drains through curb and gutter to an existing storm drain system inlet. Approximately 1.99 acres of drainage area with 1.34 acres of impervious area drain to the existing stream.

Figure B-44: Facing south toward the parking lot adjacent to Emmorton Recreation Office (left); Facing north at the existing inlet in the parking lot adjacent to Emmorton Recreation Office (right)

Recommended Restoration Actions

- A bioretention facility is proposed in the flat area between two Emmorton Recreation Office buildings, located downstream of the parking lot to treat impervious area runoff (Figure B-45). The soils in the area are hydrologic soil type C, indicating low infiltration rates. An underdrain is recommended to convey treated runoff that does not infiltrate into the ground to the nearby stream.

- The proposed bioretention has the potential to treat 1.37 impervious acres.
- Proposed BMP plans are shown in Figure B-46.

Figure B-45: Facing east toward the Emmorton Recreation Office building (left); Facing north toward the existing outfall channel adjacent to the Emmorton Recreation Office building (right)

Threats to Infrastructure

- There is no critical infrastructure in the project limits.
- There are surrounding recreation buildings.
- There are no utility conflicts.

Property Ownership

- Public: Harford County

Access

- Minor Access: Existing facility located on public land. Some mature trees near vicinity of proposed BMP footprint.

Summary of Restoration Improvements

A summary of improvements for the proposed bioretention facility are shown in Table B-30. The table includes the drainage area, the impervious area within the drainage area, the impervious area treated, and the pollutant load reductions. The quantity of impervious area treated is dependent on the rainfall depth of water treated. The proposed bioretention facility treats 1.0-inch of rainfall which corresponds to 1 impervious acre credit per acre of watershed impervious area. This proposed bioretention facility would provide a total of 1.37 impervious acres of treatment. This bioretention facility would provide a pollutant load reduction of 61% for nitrogen, 71% for phosphorus, and 76% for sediment (Schueler, 2015).

Project Costs

Total project costs are $165,384 for the proposed bioretention. Project costs are broken down by cost per impervious acre treated (Table B-31). BMP construction costs were based on actual Maryland

bioretention construction costs and engineering judgement. Design costs were estimated as a percentage of the construction costs to provide total project costs.

Table B-30: Summary of Improvements for Proposed BMP-P-7

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)	TN REDUCTIONS (LBS/YEAR)	TP REDUCTIONS (LBS/YEAR)	TSS REDUCTIONS (LBS/YEAR)
BMP	BMP-P-7	1.99	1.34	-	1.37	22.93	1.21	2,699
Outfall								
Stream								
Total Credit/ Reductions					1.37	22.93	1.21	2,699

Table B-31: Summary of Project Costs for Proposed BMP-P-7

PROJECT TYPE	PROJECT NAME	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
BMP	BMP-P-7	$165,384	$121,001
Outfall			
Stream			
Total Costs		$165,384	$121,001

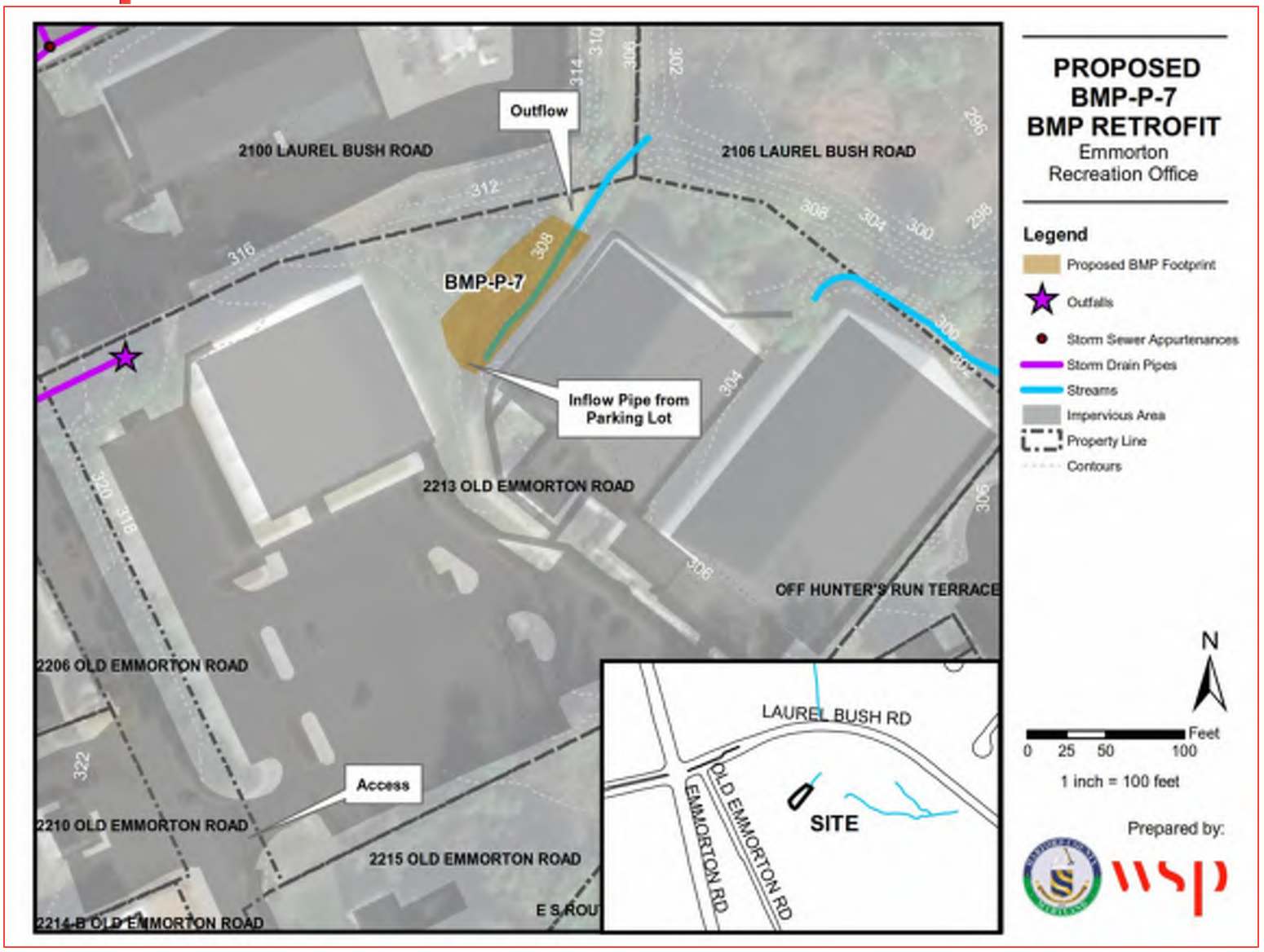

Figure B-46: Proposed BMP-P-7 Site Location

APPENDIX C STREAM AND OUTFALL RESTORATION PROJECTS

Combination stream restoration and outfall stabilization projects are presented in this appendix. Seventeen projects have been recommended for the Lower Bynum Run watershed. These projects include stream restorations from 743 linear feet to 3,354 linear feet. Eight projects are stream restoration only projects, three are outfall stabilization only projects, and the remaining six projects are a combination of stream restoration and outfall stabilization projects. Outfalls have been identified at the headwater of the stream or on the left or right bank of the stream that need repair, replacement, or stabilization. Table C-3 lists all 17 stream and outfall restoration projects.

Each project description begins with an "at a glance" summary of the recommended restoration, the location of the project, the number of properties impacted, the pollutant load reductions and impervious area treated. The project description also includes a site description, recommended actions, threats to infrastructure, impacted property addresses, a cost estimate, and a map showing the extents of the project.

Cost estimates for each stream restoration project are based on three project sizes: small, medium, and large. Small projects have less than 1,000 linear feet of restoration, medium projects have between 1,000 and 3,000 linear feet of stream restoration, and large projects have more than 3,000 linear feet of stream restoration. Each project type was assigned a cost per linear foot; small projects had a higher cost per linear feet than large projects due to economies of scale. These values were estimated based on estimates from other Maryland counties as well as state agencies. The cost estimates for the types of stream projects are shown in Table C-1.

Table C-1: Stream Design and Construction Cost Estimates for Small, Medium, and Large Stream Projects

Project Type	Cost/L.F.
Small	$750
Medium	$650
Large	$550

Several of the stream projects include outfall stabilization efforts. A cost was assigned to each outfall and added to the overall stream and outfall restoration project cost estimate. The outfall cost was assigned a cost related to the magnitude of the project. Small projects require a design component along with grading and riprap stabilization. Medium projects require a design component plus a new outfall structure, plunge pool, and less than 40 feet of additional pipe. Large projects include all items in the medium project list; however, the amount of additional pipe needed to convey flow to the stream is greater than 40 feet. Table C-2 provides the breakdown of cost for the small, medium, and large outfall and stream projects.

Table C-2: Cost Estimates for Outfall Stabilization Projects

Outfall Project Type	Project Cost
Small	$25,000
Medium	$50,000
Large	$100,000

Outfall maintenance is an additional cost category associated with the stream restoration projects. Outfall maintenance to remove accumulated sediment or replace an endwall is estimated at $5,000 for each outfall.

Table C-3. Stream and Outfall Restoration Project Summary

PROJECT NAME	TYPE	LENGTH OF STREAM RESTORATION (FT)	LENGTH OF OUTFALL RESTORATION (FT)	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	IMPERVIOUS AREA TREATED (ACRES)	TN REDUCTIONS (LBS/YR)	TP REDUCTIONS (LBS/YR)	TSS REDUCTIONS (LBS/YR)	PROJECT COST	COST/IMPERVIOUS ACRE TREATED
MSB-2A	Stream Restoration	2,220		88.96	14.58	44.40	166.50	150.96	33,300	$1,443,000	$32,500
MSB-2B	Stream Restoration	1,160		65.69	18.41	23.21	87.00	78.88	17,405	$769,000	$33,132
MSB-2C	Outfall Restoration		55	10.00	3.23	0.55	N/A	N/A	N/A	$50,000	$90,909
MSB-4A	Stream Restoration	2,385		178.08	48.6	71.54	178.85	162.16	107,070	$1,550,250	$21,809
MSB-4B	Stream and Outfall Restoration	2,440	95	646.26	148.90	74.16	183.00	165.92	109,556	$1,686,000	$22,735
MSB-4C	Stream Restoration	1,296		154.51	15.93	38.89	97.22	88.15	58,202	$842,400	$21,661
MSB-4D	Stream and Outfall Restoration	2,105	100	286.51	78.08	64.15	157.88	143.14	94,515	$1,518,250	$23,667
MSB-4E	Stream and Outfall Restoration	3,325	12	425.28	105.19	99.87	249.38	226.11	149,297	$1,853,750	$18,562
MSB-4F	Outfall Restoration		96	7.30	2.60	0.96	N/A	N/A	N/A	$25,000	$26,042
MSB-4G	Stream and Outfall Restoration	160	30	15.50	6.60	5.10	12.00	10.88	7,184	$170,000	$33,333
MSB-5A	Stream Restoration	2,058		24.23	3.91	61.74	154.35	139.94	92,404	$1,337,700	$21,667
MSB-5B	Stream Restoration	1,327		96.10	24.61	39.80	99.51	90.22	59,571	$872,550	$21,923
MSB-5C	Stream and Outfall Restoration	3,236	137	231.06	51.46	98.46	242.71	220.06	145,304	$2,005,150	$20,365
MSB-5D	Stream and Outfall Restoration	3,354	216	107.52	20.33	102.76	251.58	228.10	150,615	$1,969,700	$19,168
MSB-5E	Stream Restoration	743		147.23	24.82	22.28	55.69	50.49	33,339	$556,890	$24,995
MSB-5F	Outfall Restoration		90	14.10	4.76	0.90	N/A	N/A	N/A	$100,000	$111,111
MSB-6A	Stream Restoration	2,649		169.76	47.22	79.46	198.64	180.10	118,919	$1,721,850	$21,669
Total		**28,458**	**831**	**2,668.09**	**619.23**	**828.23**	**2,134.31**	**1,935.11**	**1,176,681**	**$18,471,490**	

MSB-2A STREAM RESTORATION

Project Description	Restore 2,220 feet of stream
Location	Hidden Brook Court
Property Ownership	Five private properties
Length of Project	2,220 feet of stream restoration
Potential Impervious Acres Treated	44.40 Acres
Potential Load Reductions TP	150.96 lbs/yr
Potential Load Reductions TN	166.50 lbs/yr
Potential Load Reductions TSS	33,300 lbs/yr
Estimated Design/Construction Costs	$1,443,000 $32,500/ impervious acres treated
Adjacent Projects	SWM000472 and SWM000683

Site Description

MSB-2A is south of Hidden Brook Court and west of Swift Run Court. This project contains 2,220 feet of proposed stream restoration, including the main stem and a tributary. The stream project ends at the confluence of the tributary and main stem. No outfalls within this stream project are recommended for stabilization or maintenance. The main stem experiences severely eroded banks for the first 883 feet and has an average exposed bank height of 7 feet (Figure C-1, left). The stream channel is steeper in this section. As the channel slope decreases, the eroded bank heights decrease to 2-feet, with low severity erosion (Figure C-2, left). The SWM000683 BMP outfall channel is eroded approximately 70 feet prior to entering the main stem (Figure C-1, right).

Figure C-1: Left bank severely eroded (left); Left and right banks are severely eroded and channel is dry (right).

Throughout the stream there is some deposition (Figure C-2, left). There are two headcuts, one 3 feet and the other 4 feet (Figure C-2, right). Lastly, there is some debris accumulation and one area with trash in the stream.

Figure C-2: Stream deposition (left); 4-foot headcut along tributary (right).

Recommended Restoration Actions

- **Stream Restoration**
    - *MSB-2A, main stem:* 2,220 feet from approximately 370 feet downstream of Outfall 1 to the confluence with a tributary in Abingdon Estates HOA.
- Proposed project limits are shown in Figure C-3, Figure C-4, and Figure C-5.

Threats to Infrastructure

- There is no threat to infrastructure within the project area.

Property Ownership

There are several private property owners along this reach. The majority of the stream project is located within HOA property. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: LLC, 3605 Philadelphia Road
- Private: HOA, Abingdon Estates Homeowner's Association Inc.
- Private: HOA, Hidden Stream Homeowner's Association Inc.
- Private: Cogswell Court
- Private: HOA, Cokesbury Manor Community Association Inc.

Access

- Moderate Access at SWM000472 easement, east of the BMP, located between 1219 and 1220 Lobo Court for stream restoration.
- Moderate Access at SWM000683 between 1300 and 1302 Hidden Brooke Court for stream restoration.

- Moderate Access at Open Area west of 1312 Hidden Brooke Court for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-4. The restoration of 2,220 linear feet of stream restoration in this project will treat 44.40 impervious acres within the watershed. This treatment amount accounts for approximately 3.4% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $1,443,00 for the MSB-2A Stream Restoration project. This cost estimate includes one medium stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-5.

Table C-4:Summary of Improvements for MSB-2A Stream Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-2A	88.96	14.58	2,220	44.40	166.50	150.96	33,300
Total Credit/ Reductions				**2,220**	**44.40**	**166.50**	**150.96**	**33,300**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-5: Summary of Project Costs for MSB-2A Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-2A	Medium	$650	L.F.	$1,443,000	$32,500
Total Costs					**$1,443,000**	**$32,500**

*Project cost divided by stream restoration impervious area treated

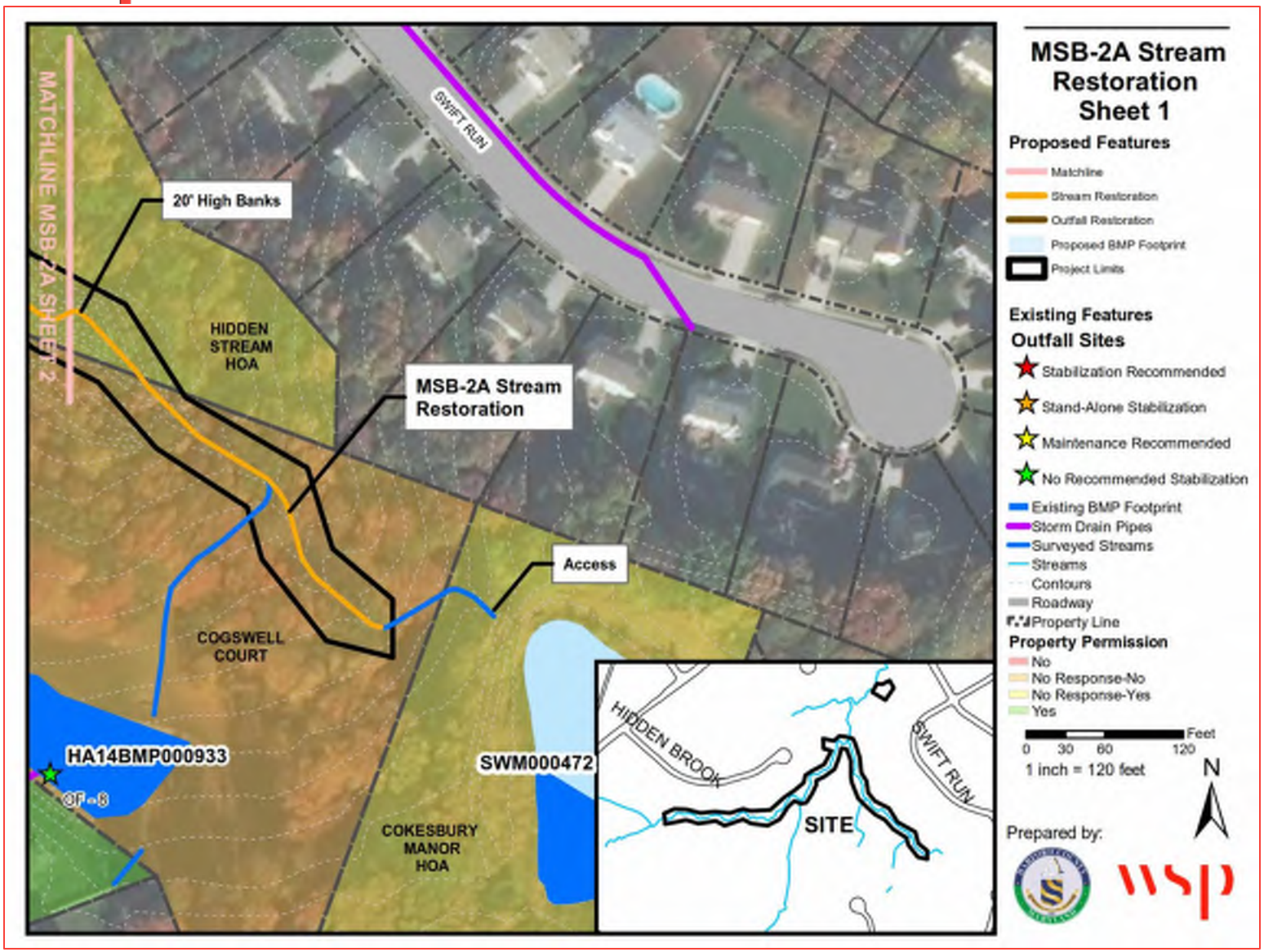

Figure C-3: Site Location and Proposed Project Plan for MSB-2A Stream Restoration (Sheet 1 of 3)

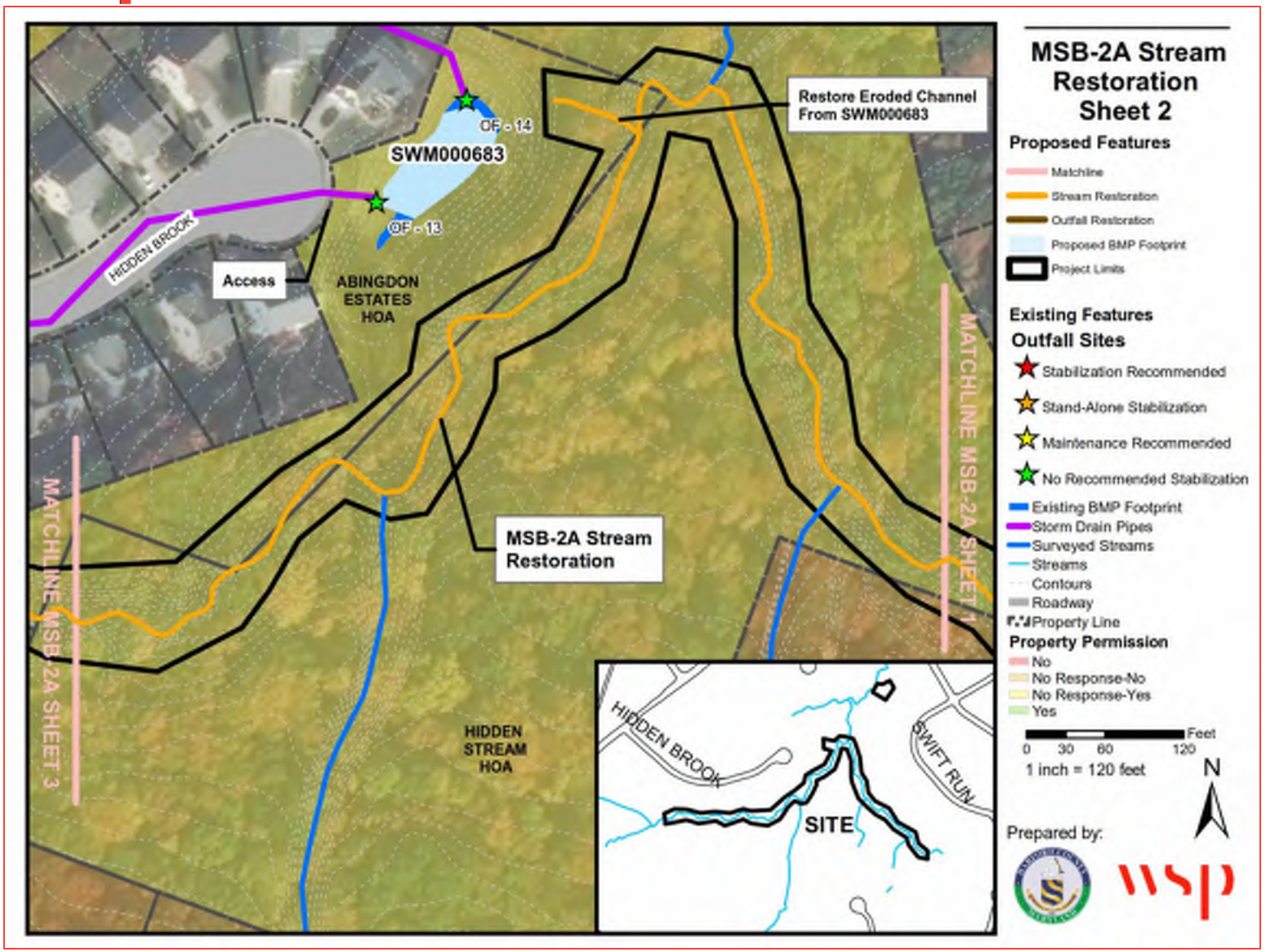

Figure C-4: Site Location and Proposed Project Plan for MSB-2A Stream Restoration (Sheet 2 of 3)

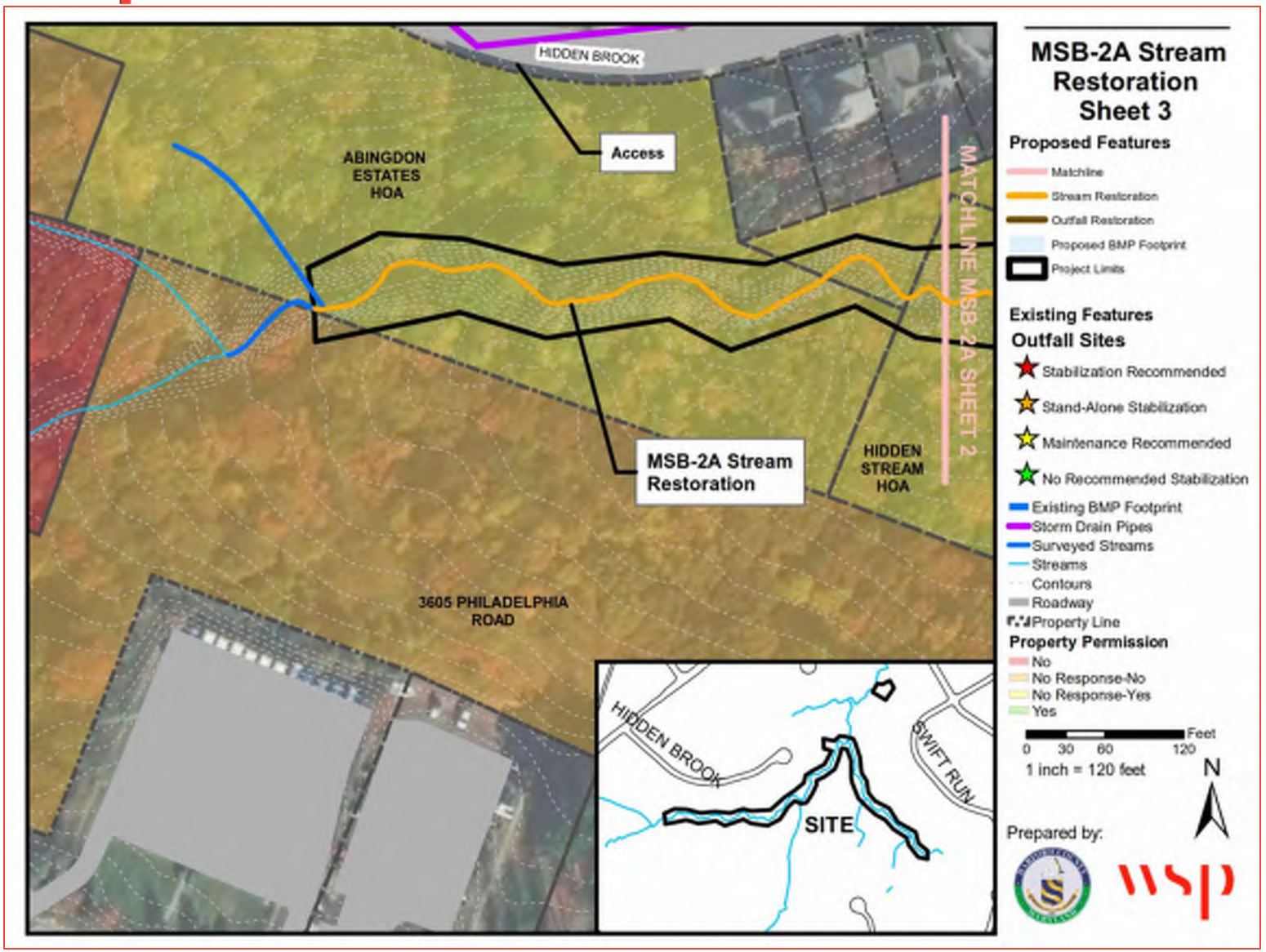

Figure C-5: Site Location and Proposed Project Plan for MSB-2A Stream Restoration (Sheet 3 of 3)

MSB-2B STREAM RESTORATION

Project Description	Restore 1,160 feet of stream
Location	Swift Run Drive and Harford Town Drive
Property Ownership	Two private properties
Length of Project	1,160 feet of stream restoration
Potential Impervious Acres Treated	23.21 Acres
Potential Load Reductions TP	78.88 lbs/yr
Potential Load Reductions TN	87.00 lbs/yr
Potential Load Reductions TSS	17,405 lbs/yr
Estimated Design/Construction Costs	$769,000 $33,132/impervious acres treated
Adjacent Projects	None

Site Description

The upstream limit of MSB-2B is located between Splashing Brook Drive and Harford Town Drive. It proposes a total of 1,160 feet of stream restoration and maintenance of outfalls 18, 23, and 24. There are an additional 4 outfalls within the vicinity of this project which are not recommended for stabilization or maintenance. The main stem of the stream contains multiple erosion sites of varying severity. At the upstream limits, there is low severity erosion with an average exposed bank height of 2 feet on both the left and right banks. This continues for approximately 222 feet downstream. The remaining length of the main stem includes severe erosion on the left bank and moderate erosion on the right bank. For the first 430 feet, the left and right bank heights are 3 feet (Figure C-6, left). The next 380 feet of stream, the exposed bank height on the left increases to 7 and the right height increases to 5 feet (Figure C-6, left). In the final 250 feet of the main stem, the exposed bank heights are reduced to an average of 3 feet on both sides.

Figure C-6: Start of severe left bank and moderate right bank erosion within MSB-2B (left); Deposition and debris jams (right)

Outfall 18 is located approximately 370 feet downstream from the beginning of the stream project. This outfall is the only outfall assessed that was in the Harford County GIS database and was less than 12 inches. The outfall is a 6-inch overflow pipe from a BMP that is also not in the Harford County BMP

database. The pipe extends 5 feet from the edge of the right stream bank, leaving it susceptible to damage from debris. Severe erosion has occurred along the banks near Outfall 18 (Figure C-7, right).

A tributary converges on the main stem near the end of the stream restoration project. The tributary conveys flow from a storm drain network (Outfall 23) along Harford Town Drive. A portion of the flow from this storm drain network is diverted into a BMP. Outfall 24 is the outlet of the BMP and flows directly into the main stem, approximately 85 feet upstream of the end of the project area. The tributary experiences active erosion with an average exposed height of 4 feet from the channel of outfall 23 (Figure C-7, left).

Figure C-7: Severe erosion around overflow pipe, Outfall 18 (left); Headcut at the intersection of the channel of Outfall 23 with the main stem (right).

Recommended Restoration Actions

- **Stream Restoration**
    - *MSB -2B Main stem*: 1,077 feet from approximately 650 feet downstream of Outfall 11 to the outlet at Harford Town Drive.
    - *MSB-2BR, Tributary*: 83 feet from 40 feet downstream of Outfall 23 to the confluence with the main stem.
- **Outfall Maintenance**
    - *Outfalls 18:* Repair 12-inch pipe when restoring stream channel
    - *Outfall 23:* Shift riprap back into outfall channel and tie end of outfall channel in with stream restoration
    - *Outfall 24:* Remove sediment from outfall pipe and outfall channel to restore positive grade towards stream
- Proposed project limits are shown in Figure C-8 and Figure C-9.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are two private property owners along this reach and coordinating buy in from them at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Harford Town Homeowners Association Inc.
- Private: 1202 Harford Town Drive

Access

- Good Access at the corner of Cooper Beech Drive and Swift Run Road for stream restoration.
- Good Access at the easement between 1146 and 1148 Harford Town Drive for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-6. The construction of 1,160 linear feet of stream restoration in this project will treat 23.21 impervious acres within the watershed. This treatment amount accounts for approximately 1.8% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $769,000 for the MSB-2B Stream Restoration project. This cost estimate includes three outfall maintenance projects and one medium stream restoration project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-7.

Table C-6: Summary of Improvements for MSB-2B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance	OF-18	-	-	-	-	-	-	-
	OF-23	-	-	-	-	-	-	-
	OF-24	-	-	-	-	-	-	-
Outfall								
Stream	MSB-2B	65.69	18.41	1,160	23.21	87.00	78.88	17,405
Total Credit/ Reductions				**1,160**	**23.21**	**87.00**	**78.88**	**17,405**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-7: Summary of Project Costs for MSB-2B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance	OF-18	Small	$5,000	Project	$5,000	
	OF-23	Small	$5,000	Project	$5,000	
	OF-24	Small	$5,000	Project	$5,000	
Outfall						
Stream	MSB-2B	Medium	$650	L.F.	$754,000	$32,486
Total Costs					**$769,000**	**$33,132**

*Project cost divided by stream restoration impervious area treated

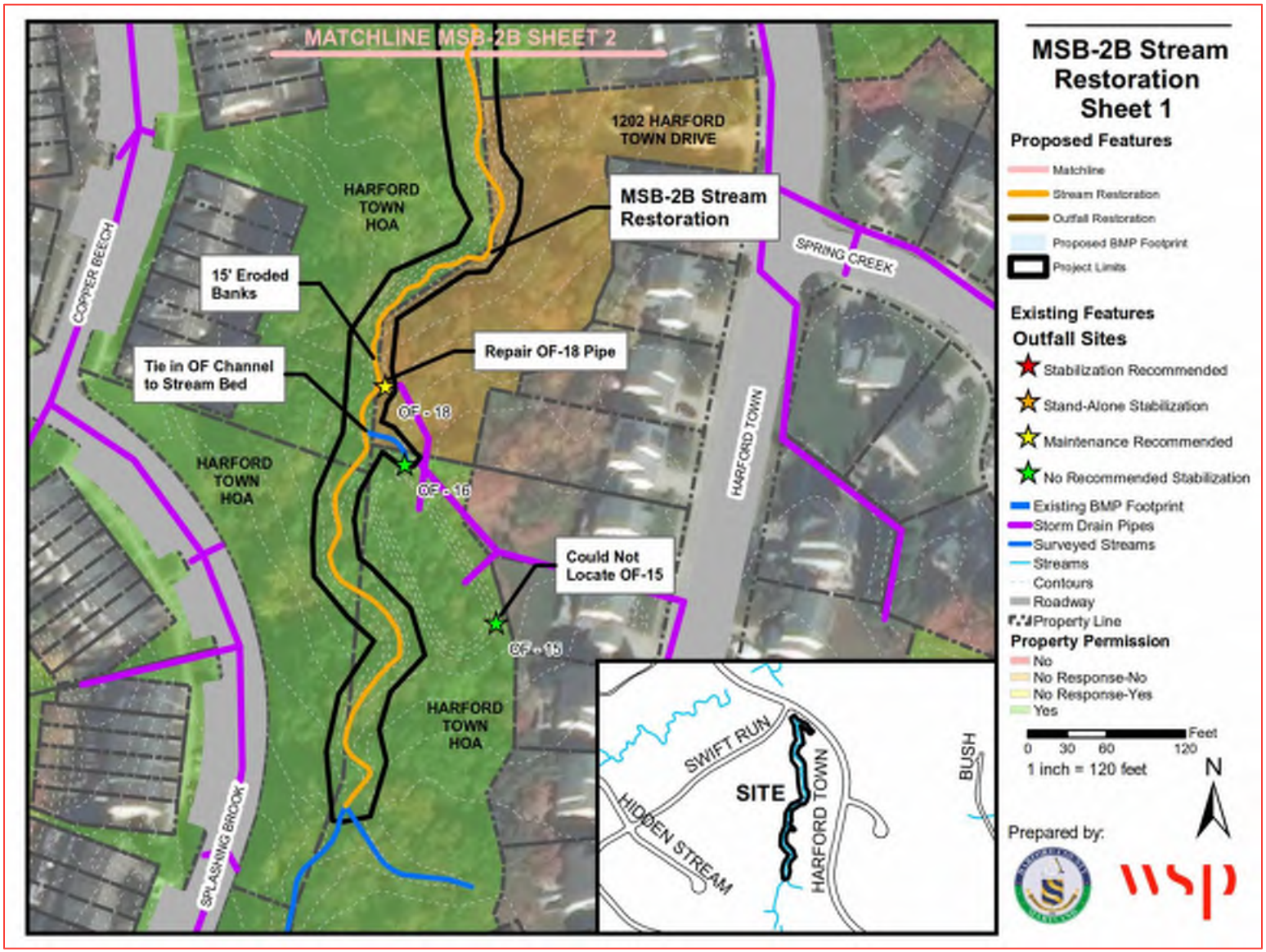

Figure C-8: Site Location and Proposed Project Plan for MSB-2B Stream Restoration (Sheet 1 of 2)

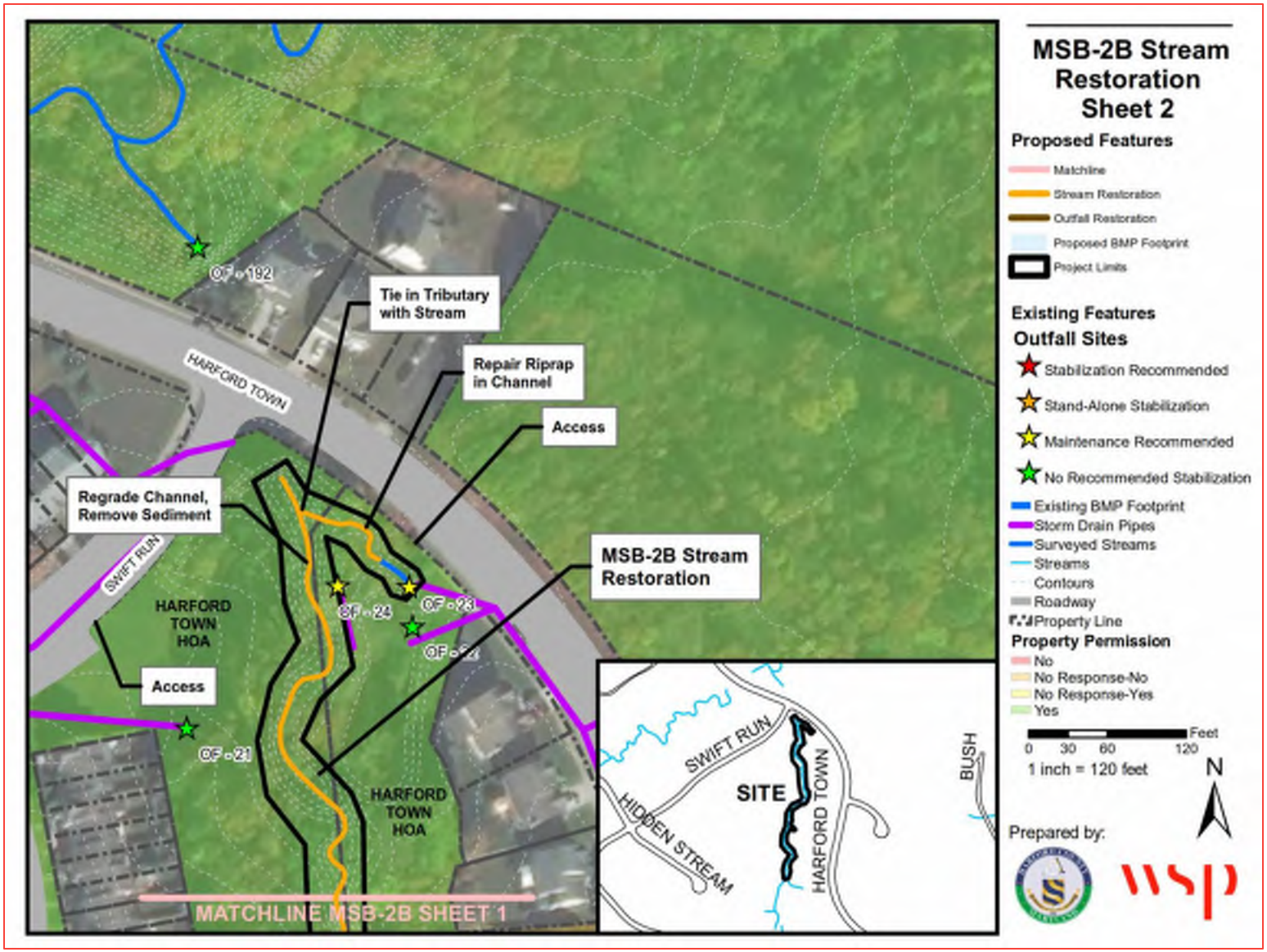

Figure C-9: Site Location and Proposed Project Plan for MSB-2B Stream Restoration (Sheet 2 of 2)

MSB-2C OUTFALL RESTORATION

Project Description	Stabilize 55 feet of channel at Outfall 17
Location	Swift Run Drive and Hidden Stream Drive
Property Ownership	One private property
Length of Project	55 feet of outfall stabilization
Potential Impervious Acres Treated	0.55 Acres
Potential Load Reductions TP	N/A
Potential Load Reductions TN	N/A
Potential Load Reductions TSS	N/A
Estimated Design/Construction Costs	$50,000 $90,909/impervious acres treated
Adjacent Projects	None

Site Description

The upstream limit of MSB-2C is located between Swift Run Court and Hidden Stream Drive. It proposes a stand-alone stabilization of Outfall 17 which receives discharge from the southeastern portion of the Hidden Stream community. The outfall consists of a 30-inch diameter RCP pipe and a concrete end section. Both the outfall pipe and end section are in good condition (Figure C-10). The outfall channel protection is comprised of riprap and extends approximately 55 feet until the channel's confluence with its receiving stream. A 4-foot headcut is located 30 feet downstream of the end section, where the riprap protection has been pushed downstream, leaving exposed geotextile. Downstream of the headcut, there is an additional exposed, 6-inch underdrain PVC pipe, surrounded by eroded, bare earth where geotextile and riprap have been disturbed, which is visible from the receiving stream channel (Figure C-11).

Figure C-10: Upstream view of OF-17 pipe and structure (left); Downstream view of OF-17 channel (right)

Figure C-11: Headcut and exposed geotextile (left). Outfall 17 confluence with stream (right).

Recommended Restoration Actions

- **Outfall Stabilization:**
    - *Outfall 17:* Fill in sediment basin, install plunge pool, grade channel towards stream, and line with riprap protection.
- Proposed project limits are shown in Figure C-12.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are two private property owners along this reach and coordinating buy in from them at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Hidden Stream Homeowners Association Inc.
- Private: 3724 Swift Run Court
- Private: 3726 Swift Run Court

Access

Good Access between 3724 Swift Run Court and 3726 Swift Run Court for outfall stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-8. The construction of 55 linear feet of outfall stabilization in this project will treat 0.55 impervious acres within the watershed. This treatment amount accounts for approximately 0.04% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $50,000 for the MSB-2C Outfall Restoration project. This cost estimate includes one medium outfall stabilization project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-9.

Table C-8: Summary of Improvements for MSB-2C Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-17	10	3.23	55	0.55	-	-	-
Stream								
Total Credit/ Reductions				**55**	**0.55**	**-**	**-**	**-**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-9: Summary of Project Costs for MSB-2C Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-17	Medium	$50,000	Project	$50,000	
Stream						
Total Costs					**$50,000**	**$90,909**

*Project cost divided by stream restoration impervious area treated

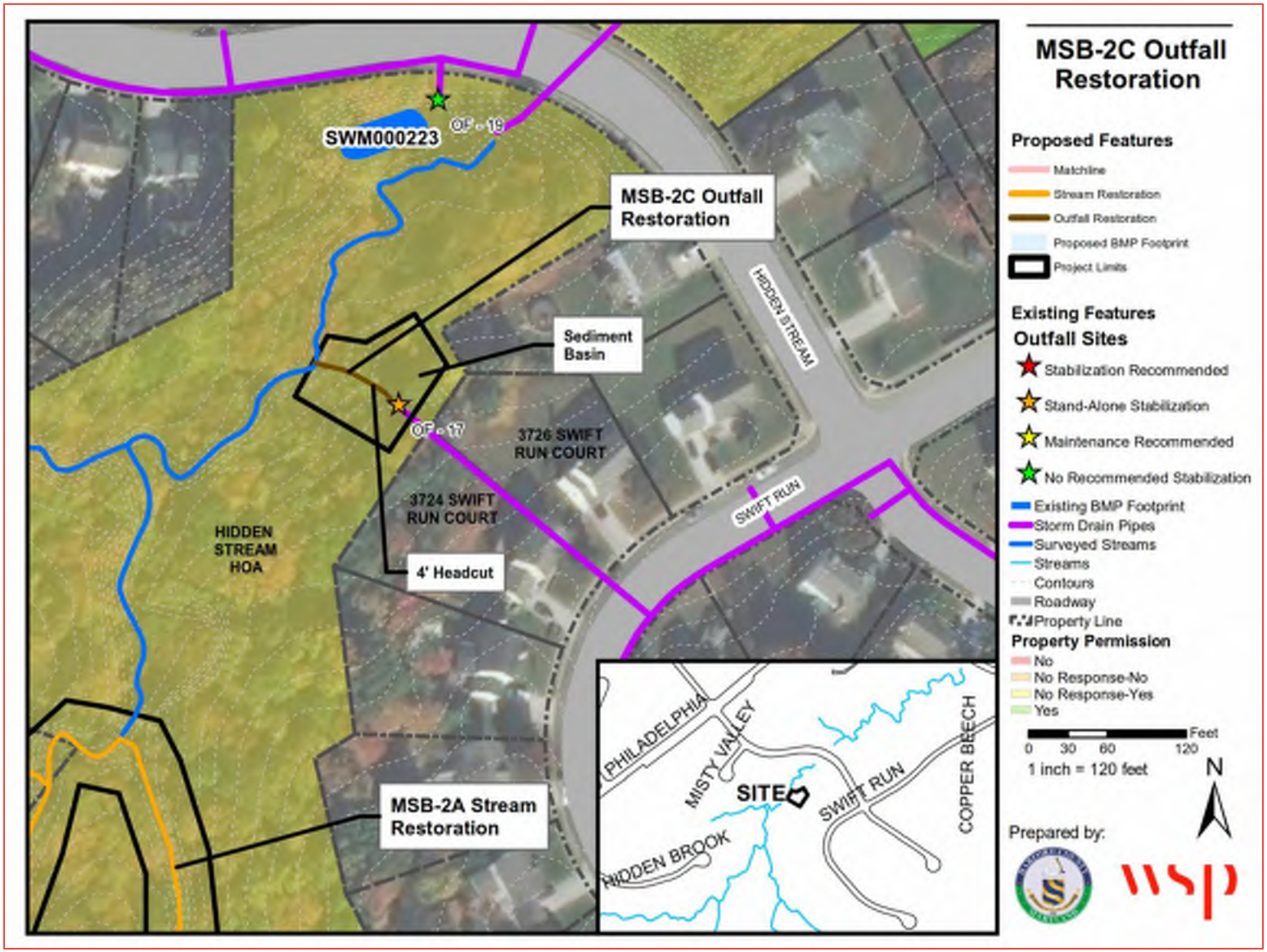

Figure C-12: Site Location and Proposed Project Plan for MSB-2C Outfall Restoration

MSB-4A STREAM RESTORATION

Project Description	Restore 2,385 feet of stream
Location	Royal Oak Drive to Hunters Run Drive
Property Ownership	16 Private Properties
Length of Project	Restore 2,385 feet of stream restoration
Potential Impervious Acres Treated	71.54 Ac
Potential Load Reductions TP	162.16 lbs/yr
Potential Load Reductions TN	178.85 lbs/yr
Potential Load Reductions TSS	107,070 lbs/yr
Estimated Design/Construction Costs	$1,560,250 $21,809/impervious acres treated
Adjacent Projects	MSB-4B Stream Restoration

Site Description

MSB-4A consists of two main stem stream segments and one tributary. The main stem is split by Bright Oaks Road. The tributary flows into the main stem (segment 2) reach approximately 500 feet downstream of outfalls 71 and 168. In addition to the stream restoration, two outfalls are recommended for maintenance.

MSB-4A, Segment 1, is located south of Whitney Ln and North of Rainier Ave, running parallel to the road. It contains 1,190 feet of proposed stream restoration and four outfalls, two of which are proposed for maintenance (Figure C-13). Outfall 66 and Outfall 68 are both 15-inch CMP pipes with concrete endwalls. Outfall 68 is located 450 feet downstream of the beginning of MSB-4A, Segment 1. The end pipe and endwall are both hovering over the stream channel a couple of feet. The concrete outfall protection has broken away from the endwall. Outfall 66 is located an additional 500 feet downstream of Outfall 68. The structure and endwall is in good condition; however, flow exits the pipe and flows under the concrete channel protection.

Figure C-13: Outfalls proposed for maintenance, OF-66 (left); and Outfall 68 (right)

Along the right bank there are three 4 in PVC diameter downspout pipes. Approximately 360 feet downstream of the start of MSB-4A, there is a debris jam that is too high to allow fish passage (Figure C-14). The last 760 feet of the left bank have an inadequate buffer of only shrubs and small trees.

Figure C-14: Debris jam/fish barrier

At the beginning of MSB-4A, Segment 1 reach, there is over 100 feet of minor erosion containing average exposed banks of 2 feet (Figure C-15, left). The last 858 feet of stream have average exposed bank heights of 4 feet (Figure C-15, right).

Figure C-15: Minor erosion on left bank (left) and moderate erosion on right bank (right).

MSB-4A, Segment 2 is located between Bright Oaks Drive and Hunters Run Drive. It contains 648 feet of proposed stream restoration with a tributary flowing into the main stem approximately 430 downstream of outfall 71. Outfall 71 conveys perennial flow. The channel has eroded and the outfall protection failed in two spots creating 5-foot and 6-foot headcuts (Figure C-16).

Figure C-16: Looking upstream at Outfall 71 (left); Looking upstream to Outfall 71, failed outfall protection (right).

The tributary has moderately eroded banks containing average exposed bank heights of 5 feet. After the confluence, moderate erosion continues with average exposed bank heights of 6 feet (Figure C-17, left). The left bank changes to severe erosion and has average exposed bank heights of 5 feet. (Figure C-17, right).

Figure C-17: Moderate erosion on the right bank downstream of the confluence (left); Moderate bank erosion on right bank further downstream (right)

Recommended Restoration Actions

- **Stream Restoration**
    - *MSB-4A, Segment 1*: 1,190 feet between Outfall 70 and Bright Oaks Drive.
    - *MSB-4A, Segment 2*: 430 feet from approximately 97 feet downstream of Outfall 71 and Outfall 168 and confluence with the tributary. An additional 218 feet from the confluence to end of restoration.
    - *MSB-4A, Tributary*: 547 feet between approximately 60 feet downstream of Outfall 60 confluence with Main Stem Segment 2.

- **Outfall Maintenance**
    - *Outfall 66*: Remove 4 feet of concrete outfall protection in order to properly implement adjacent stream restoration
    - *Outfall 68*: Replace last outfall pipe segment and endwall
- Proposed project limits are shown in Figure C-18, Figure C-19, and Figure C-20.

Threats to Infrastructure

- There are no current threats to infrastructure within the project area.

Property Ownership

There are numerous private property owners along this reach. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: LLC: Art Builders Inc.
- Private: 2052 Whitney Lane
- Private: 2054 Whitney Lane
- Private: 2056 Whitney Lane
- Private: 2058 Whitney Lane
- Private: 2060 Whitney Lane
- Private: 2062 Whitney Lane
- Private: 2066 Whitney Lane
- Private: 2068 Whitney Lane
- Private: 2070 Whitney Lane
- Private: 224 Bright Oaks Drive
- Private: 2067 Rainier Avenue
- Private: 2065 Rainier Avenue
- Private: HOA, Hunter's Run Community Association Inc.
- Private: 303 Bright Oaks Drive

Access

- Good Access off Royal Oak Drive at Outfalls 69 and 70 for MSB-4A, Segment 1 stream restoration.
- Good Access at the intersection of Whitney Lane and Bright Oaks Drive for MSB-4A, Segment 1 stream restoration.
- Good Access off Hunters Run Drive at Outfalls 64 and 67 for MSB-4A, Segment 2 and tributary stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-10. The construction of 2,385 linear feet of stream restoration in this project will treat 71.54 impervious acres within the watershed. This treatment amount accounts for approximately 5.4% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,560,250 for the MSB-4A Stream Restoration project. This cost estimate includes two outfall maintenance projects as well as a medium stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-11.

Table C-10: Summary of Improvements for MSB-4A Stream Restoration

PROJECT TYPE	PROJECT NUMBER	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance	OF- 66	-	-	-	-	-	-	-
	OF-68	-	-	-	-	-	-	-
Outfall								
Stream	MSB-4A	178.08	48.60	2,385	71.54	178.85	162.16	107,070
Total Credit/ Reductions				**2,385**	**71.54**	**178.85**	**162.16**	**107,070**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions equal restoration length times 44.9 lbs/ft/yr

Table C-11: Summary of Project Costs for MSB-4A Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Impervious Removal						
Outfall Maintenance	OF- 66	Small	$5,000	Project	$5,000	
	OF-68	Small	$5,000	Project	$5,000	
Outfall						
Stream	MSB-4A	Medium	$650	L.F.	$1,550,250	$21,670
Total Costs					**$1,560,250**	**$21,809**

*Project cost divided by stream restoration impervious area treated

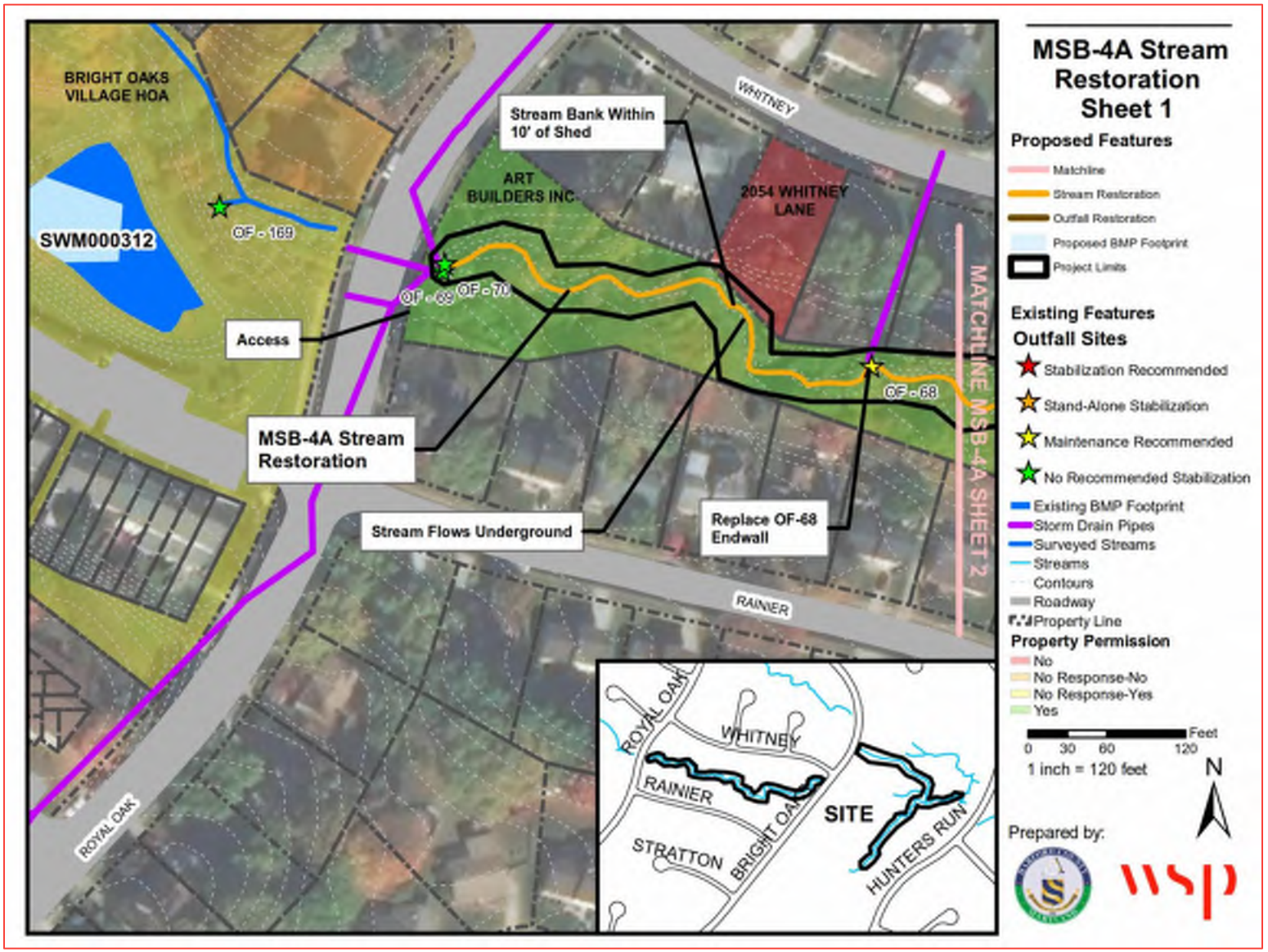

Figure C-18: Site Location and Proposed Project Plan for MSB-4A Stream Restoration (Sheet 1 of 3)

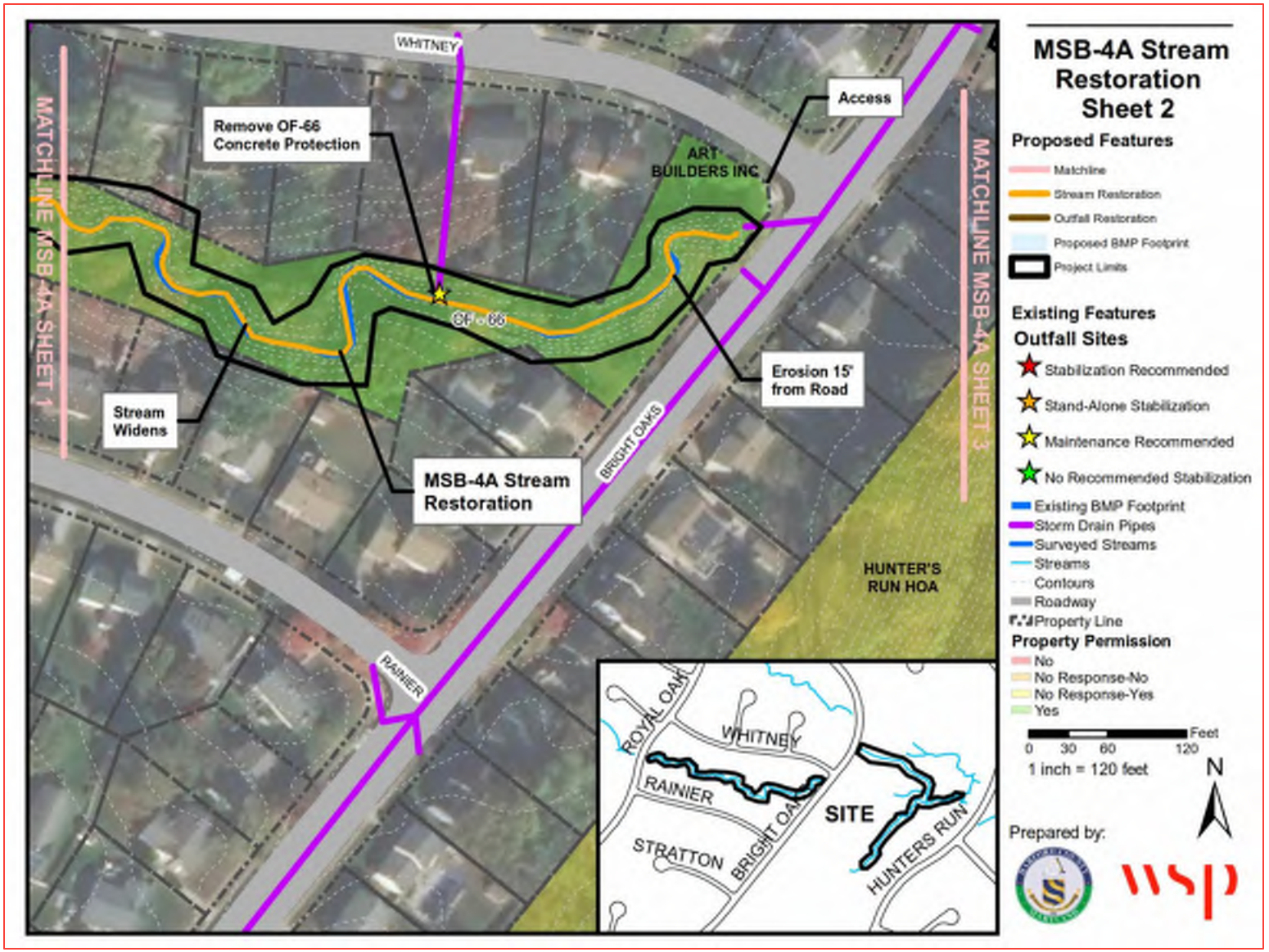

Figure C-19: Site Location and Proposed Plan for MSB-4A Stream Restoration (Sheet 2 of 3)

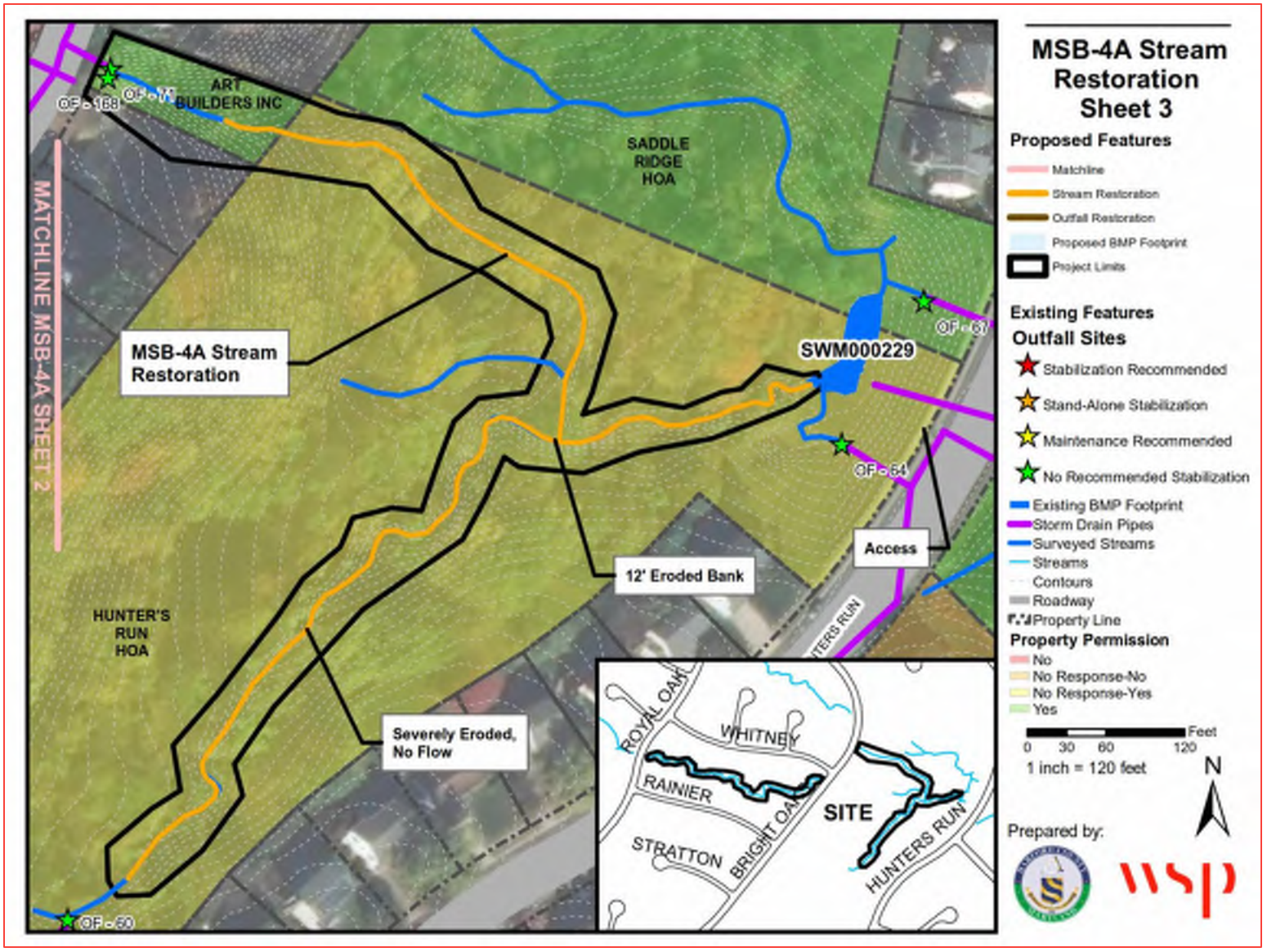

Figure C-20: Site Location and Proposed Plan for MSB-4A Stream Restoration (Sheet 3 of 3)

MSB-4B STREAM AND OUTFALL RESTORATION

Project Description	Restore 2,440 feet of stream, and stabilize 95 feet of channel at Outfall 58
Location	605 Wheel Road
Property Ownership	One Harford County Property and Seven Private Properties
Length of Project	2,440 feet of stream restoration and 95 feet of outfall stabilization
Potential Impervious Acres Treated	74.16 Acres
Potential Load Reductions TP	165.92 lbs/yr
Potential Load Reductions TN	183.00 lbs/yr
Potential Load Reductions TSS	109,556 lbs/yr
Estimated Design/Construction Costs	$1,686,000 $22,735/impervious acres treated
Adjacent Projects	None

Site Description

MSB-4B consists of 2 stream segments, for a total of 2,440 feet of stream restoration. MSB-4B, Segment 1, is located south of Gelding way and contains 1,304 feet of proposed stream restoration and two outfalls. One outfall, Outfall 58, is proposed for stabilization. The first 840 feet of the stream have average eroded bank heights of 4 feet. (Figure C-21, left). The remaining 280 ft of MSB-4B, Segment 1, becomes more eroded, with average exposed bank heights of 6 feet (Figure C-21, right). There is a 100-foot section of stream downstream of the project area that is stable before it ties into MSB-4B, Segment 2. The stable portion of the reach conveys flow to a culvert under East Wheel Road.

Figure C-21: Severe erosion on the right bank (left); Moderate erosion on the right bank further downstream (right).

Outfall 58 enters the stream on the right bank approximately 800 feet downstream of the beginning of the project. The metal apron has begun to rust and the outfall channel is steep and severely eroded (Figure C-22, left). The original outfall channel is lined in riprap. At some point, the outfall channel eroded to the west, forming a new channel for approximately 85 feet. The new channel is actively eroding

and does not have riprap protection (Figure C-22, right). The new channel and original channel converge approximately 70 feet downstream of the outfall.

Figure C-22: Rusted apron at outfall 58 (left); Looking downstream from outfall towards erosion along new channel (right)

The next 100 feet of channel is steep and 20 feet wide. Boulders and riprap line the channel. This portion of the channel appears stable (Figure C-23, left). Approximately 185 feet downstream of the outfall, the riprap channel ends, the ground levels out, and the channel becomes undefined. From the outfall to this location is about a 45-foot elevation change. Twenty feet further downstream is a 36-inch HDPE pipe that may have been installed and left in place during construction (Figure C-23, right). The pipe conveys flow parallel to the stream for 150 feet before it outfalls to the stream channel. The outfall of this 36-inch pipe is just downstream of a sewer manhole structure along the stream bank.

Figure C-23: Stable, riprap lined steep channel, Outfall 58 (left); 36-inch HDPE pipe downstream of Outfall 58 (right).

MSB-4B, Segment 2, runs parallel to Wheel Rd and contains 1,136 feet of proposed stream restoration and no outfalls. This stream segment receives flow from MSB-4B, Segment 1, after it flows under East Wheel Road as well as the stream that runs parallel to Wheel Road. The 460 feet of stream upstream of the confluence with MSB-4B, Segment 1, is severely eroded. One stream bend has a 20' high eroded stream

bank (Figure C-24, left). In other areas of this stream reach, stream banks are consistently over 7 feet high (Figure C-24, right).

Figure C-24: Severe erosion on the right bank (left); Severe erosion on the left bank (right)

Approximately 170 feet downstream from the start of the second segment, there is a downed tree causing a debris jam (Figure C-25, left). At the confluence of the main stem and MSB-4B, Segment 1, there is significant erosion on the left bank, deposition occurring on the right bank, and a wide channel (Figure C-25, right).

Figure C-25: Upstream view of the debris jam (left); Wide channels and significant erosion at confluence. (right)

About 210 feet downstream of the confluence, there is a double-barrel, concrete culvert to convey flow under a community private driveway (Figure C-26). Upstream of the culvert, deposition of cobble stones and sediment has created a wide, shallow channel. Flows through this area are causing several of the lower gabion baskets on the right bank to fail. Scouring is occurring next to the right culvert. Downstream of the culvert, the gabion baskets are collapsing, and the banks are beginning to erode.

Figure C-26: Upstream (left) and downstream (right) of driveway culvert, illustrating the failing gabion baskets.

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-4B, Segment 1*: 1,304 feet from 690 feet downstream of Outfall 63 to approximately 100 feet upstream of Wheel Road.
  - *MSB-4B, Segment 2:* 1,136 feet from 455 feet upstream of the confluence with MSB-4B, Segment 1 under Wheel Rd to 67 feet upstream of the Bynum Run confluence.
- **Outfall Stabilization**
  - *Outfall 58:* 95 feet of stabilization; remove existing 36-inch HDPE pipe, add two drop structures at outfall, grade outfall channel, and line channel with riprap.
- Proposed project limits are shown in Figure C-27, Figure C-28, Figure C-29, and Figure C-30.

Threats to Infrastructure

- There are multiple sewer and water utility crossings through the project area. The sections of erosion threaten to expose these utilities to damage once uncovered and made vulnerable to debris.

Property Ownership

There are numerous private property owners along this reach. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Hunter's Run Community Association Inc.
- Private: HOA, Saddle Ridge Homeowners Association
- Private: 513 East Wheel Road
- Private: 603 East Wheel Road

- Private: 601 East Wheel Road
- Private: 605 East Wheel Road
- Private: 607 East Wheel Road
- Public: Harford County

Access

- Moderate Access at Open Space east of East Wheel Road for MSB-4B, Segment 1 stream restoration.
- Moderate Access within the storm drain easement between 2226 Kempton Park Circle and 2228 Kempton Park Circle for Outfall 58 stabilization.
- Good Access at private drive for 600 block of East Wheel Road for access to 605 East Wheel Road and Harford County property for MSB-4B, Segment 2 stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-12. One outfall stabilization project, totaling 95 linear feet is recommended alongside 2,440 linear feet of stream restoration. The construction of 2,440 linear feet of stream restoration and 95 feet of outfall stabilization in this project will treat 74.16 impervious acres within the watershed. This treatment amount accounts for approximately 5.6% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,686,000 for the MSB-4B Stream and Outfall Restoration project. This cost estimate includes one large outfall stabilization project and one medium stream restoration project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for the project is provided in Table C-13.

Table C-12: Summary of Improvements for MSB-4B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NUMBER	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-58	14.1	4.92	95	0.95	-	-	-
Stream	MSB-4B	632.16	143.98	2,440	73.21	183.00	165.92	109,556
Total Credit/ Reductions				**2,535**	**74.16**	**183.00**	**165.92**	**109,556**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-13. Summary of Project Costs for MSB-4B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-58	Large	$100,000	Project	$100,000	
Stream	MSB-4B	Medium	$650	L.F.	$1,586,000	$21,664
Total Costs					**$1,686,000**	**$22,735**

*Project cost divided by stream restoration impervious area treated

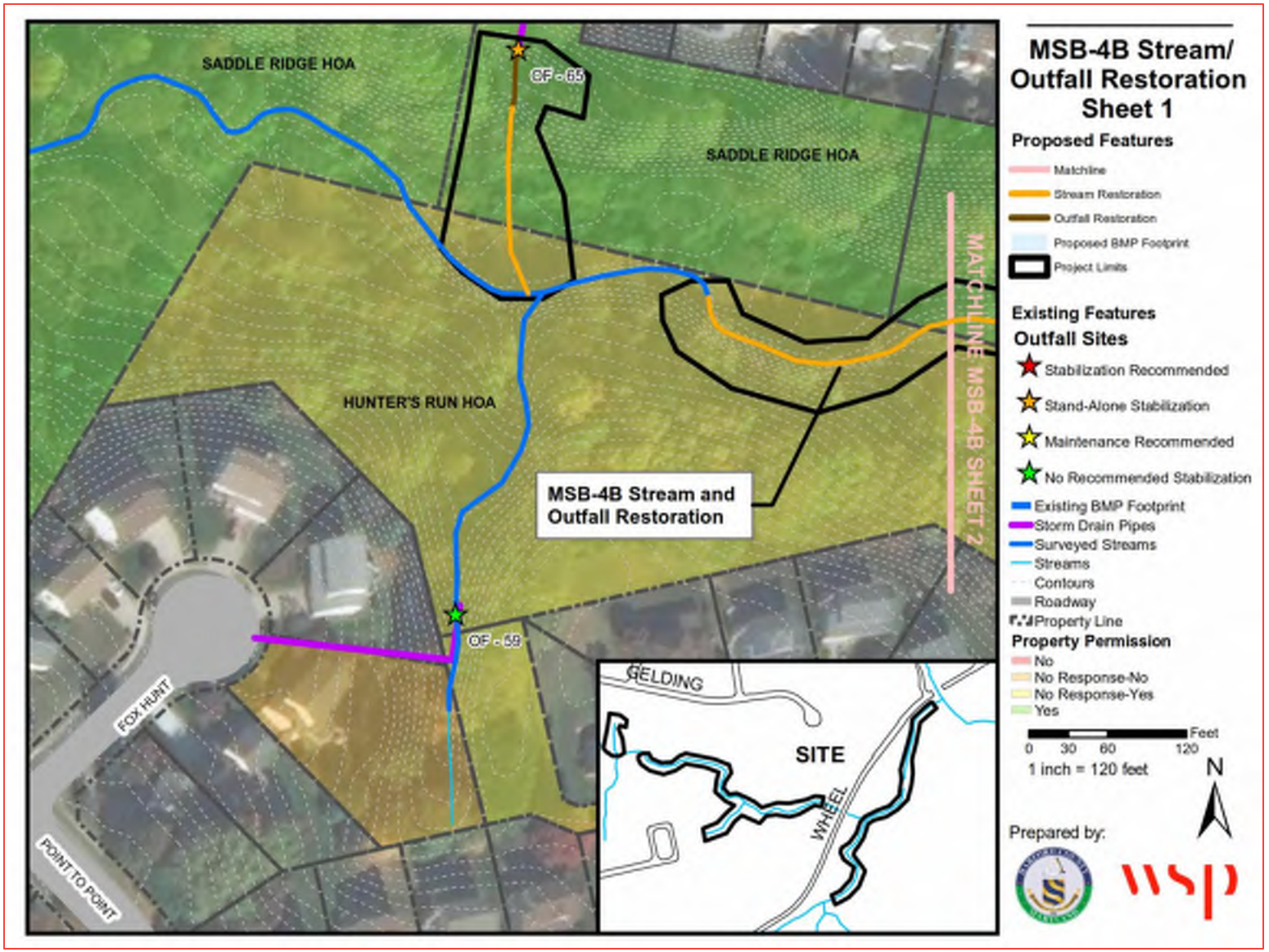

Figure C-27: Site Location and Proposed Project Plan for MSB-4B Stream and Outfall Restoration (Sheet 1 of 4)

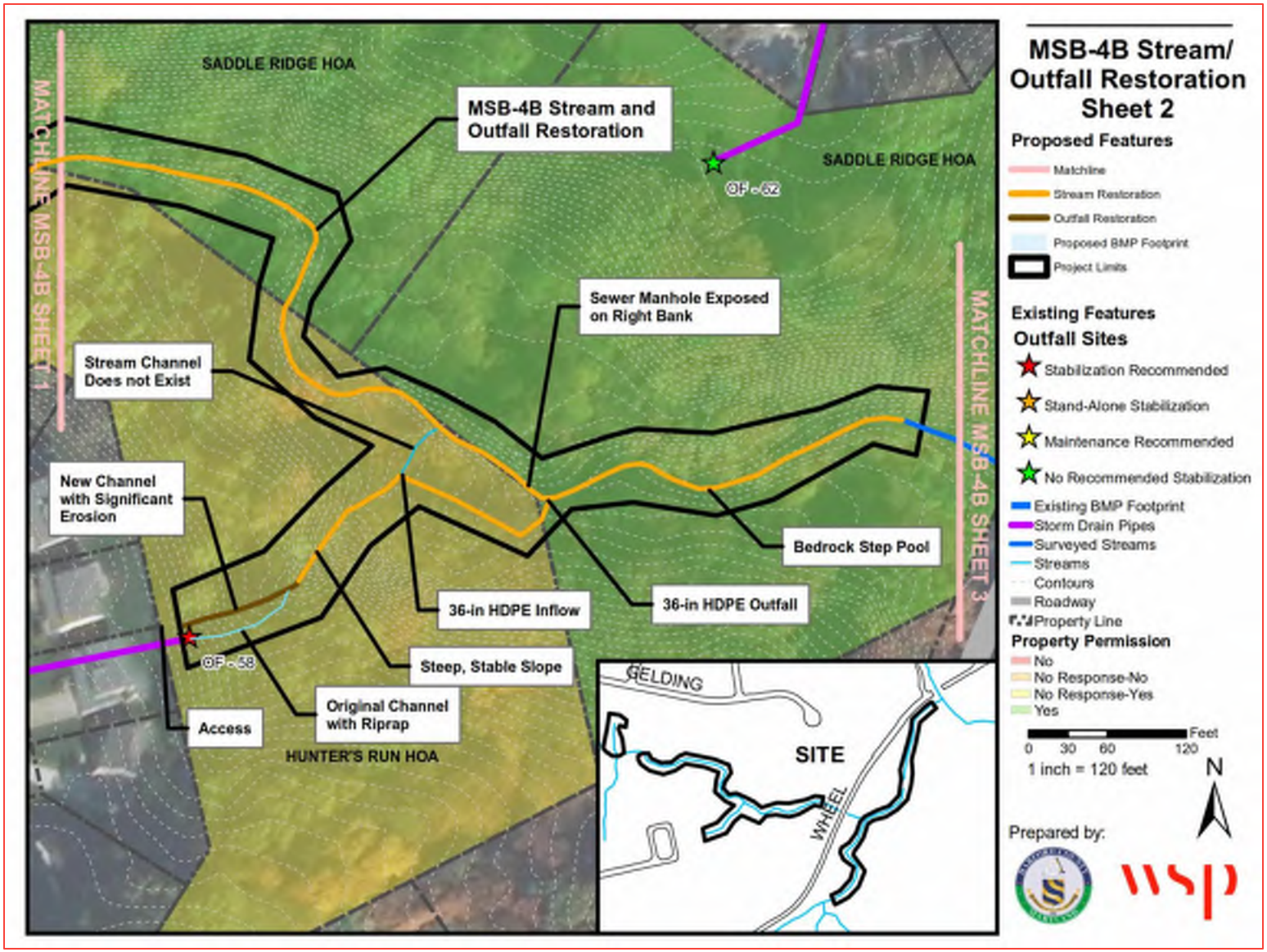

Figure C-28: Site Location and Proposed Project Plan for MSB-4B Stream and Outfall Restoration (Sheet 2 of 4)

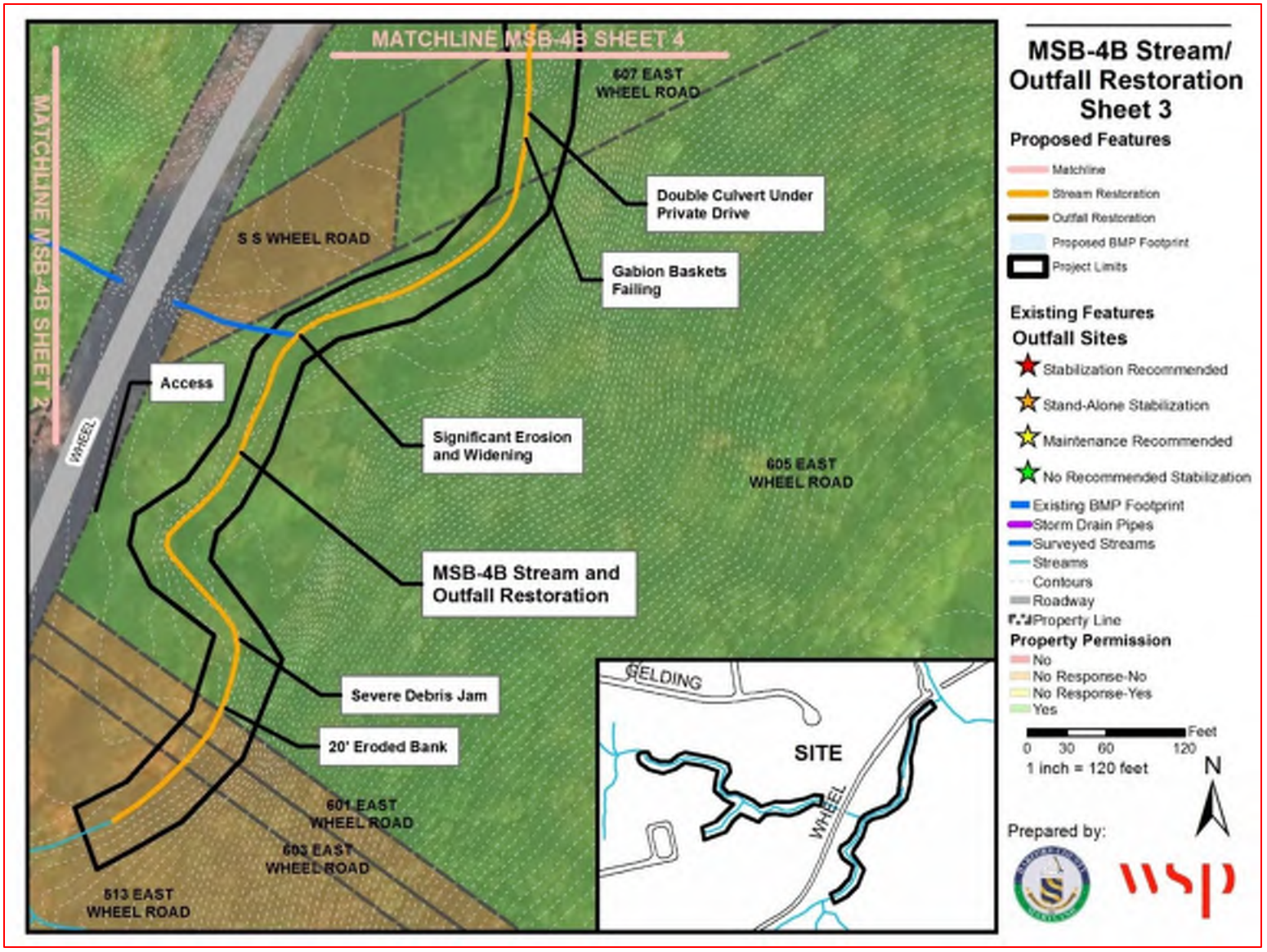

Figure C-29: Site Location and Proposed Project Plan for MSB-4B Stream and Outfall Restoration (Sheet 3 of 4)

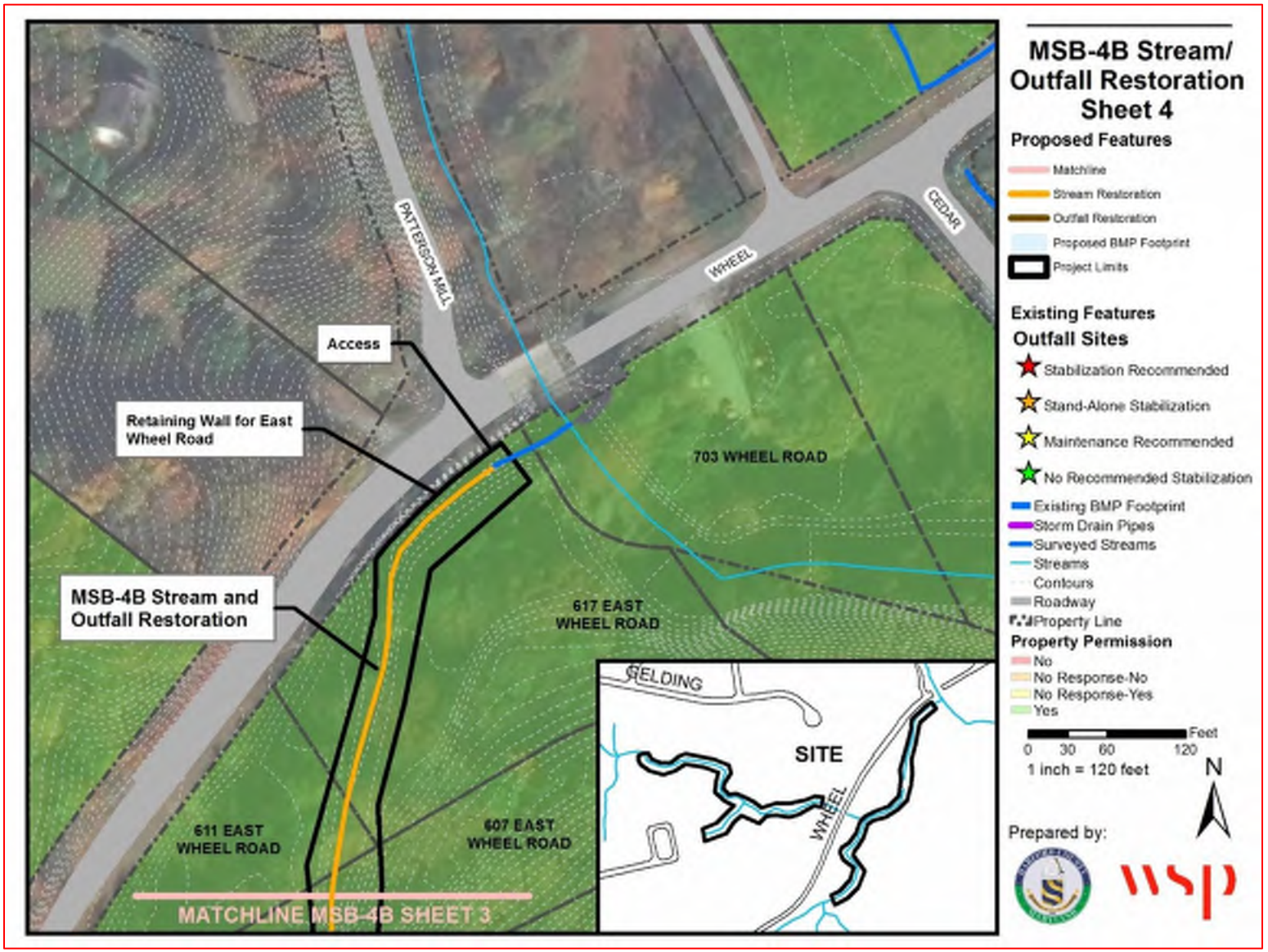

Figure C-30: Site Location and Proposed Project Plan for MSB-4B Stream and Outfall Restoration (Sheet 4 of 4)

MSB-4C STREAM RESTORATION

Project Description	Restore 1,296 feet of stream
Location	824 E. Wheel Rd to 818 E. Wheel Rd
Property Ownership	Five Private Properties
Length of Project	1,296 feet of stream restoration
Potential Impervious Acres Treated	38.89 Acres
Potential Load Reductions TP	88.15 lbs/yr
Potential Load Reductions TN	97.22 lbs/yr
Potential Load Reductions TSS	58,202 lbs/yr
Estimated Design/Construction Costs	$842,400 $21,661/impervious acres treated
Adjacent Projects	None

Site Description

MSB-4C runs parallel to East Wheel Road and contains 1,304 feet of proposed stream restoration and an outfall that is not recommended for stabilization or maintenance. At the beginning of MSB-4C, there is a bridge crossing with large boulders to protect the bank upstream (Figure C-31, left); however, there is no protection downstream where both banks have eroded. The first 1,043 feet of the left bank is severely eroded with average exposed bank heights of 4 feet (Figure C-31, right).

Figure C-31: Upstream view of the bridge (left); Severe erosion on the left bank (right)

The final 111 feet of the left bank has low severity erosion with an average exposed bank height of 3 feet. There are a couple of stream bends that are in close proximity to the road and are experiencing active erosion. Riprap from a previously stabilized stream bank, next to East Wheel Road, has been washed downstream (Figure C-32, left). Further downstream, a debris jam has caused sediment to accumulate in a stream bend (Figure C-32, right).

Figure C-32: Eroding banks within close proximity to the road creating a threat to infrastructure (left); Downstream view of the debris jam (right)

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-4C*: 1,296 feet from 162 upstream of Outfall 166 to 128 feet upstream of Outfall 165.
- Proposed project limits are shown in Figure C-33 and Figure C-34.

Threats to Infrastructure

- Erosion along outside bend of the stream channel is currently encroaching on East Wheel Road. If this erosion continues it could make the street vulnerable to collapse.

Property Ownership

There are multiple private property owners along this reach. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: LLC, 818 East Wheel Road
- Private: 820 East Wheel Road
- Private: 822 East Wheel Road
- Private: LLC, 824 East Wheel Road
- Private: 826 East Wheel Road

Access

- Good Access at 818 East Wheel Road for stream restoration.
- Good Access at 824 East Wheel Road, across private bridge, for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-14. This project recommends 1,296 linear feet of stream restoration. The construction of 1,296 linear feet of stream restoration in this project will treat 38.89 impervious acres within the watershed. This treatment amount accounts for approximately 2.9% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $842,400 for the MSB-4C Stream Restoration project. This cost estimate includes zero outfall stabilization projects and one medium stream restoration project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for the project is provided in Table C-15.

Table C-14: Summary of Improvements for MSB-4C Stream Restoration

PROJECT TYPE	PROJECT NUMBER	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-4C	154.51	15.93	1,296	38.89	97.22	88.15	58,202
Total Credit/ Reductions				**1,296**	**38.89**	**97.22**	**88.15**	**58,202**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-15: Summary of Project Costs for MSB-4C Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-4C	Medium	$650	L.F.	$842,400	$21,661
Total Costs					**$842,400**	**$21,661**

*Project cost divided by stream restoration impervious area treated

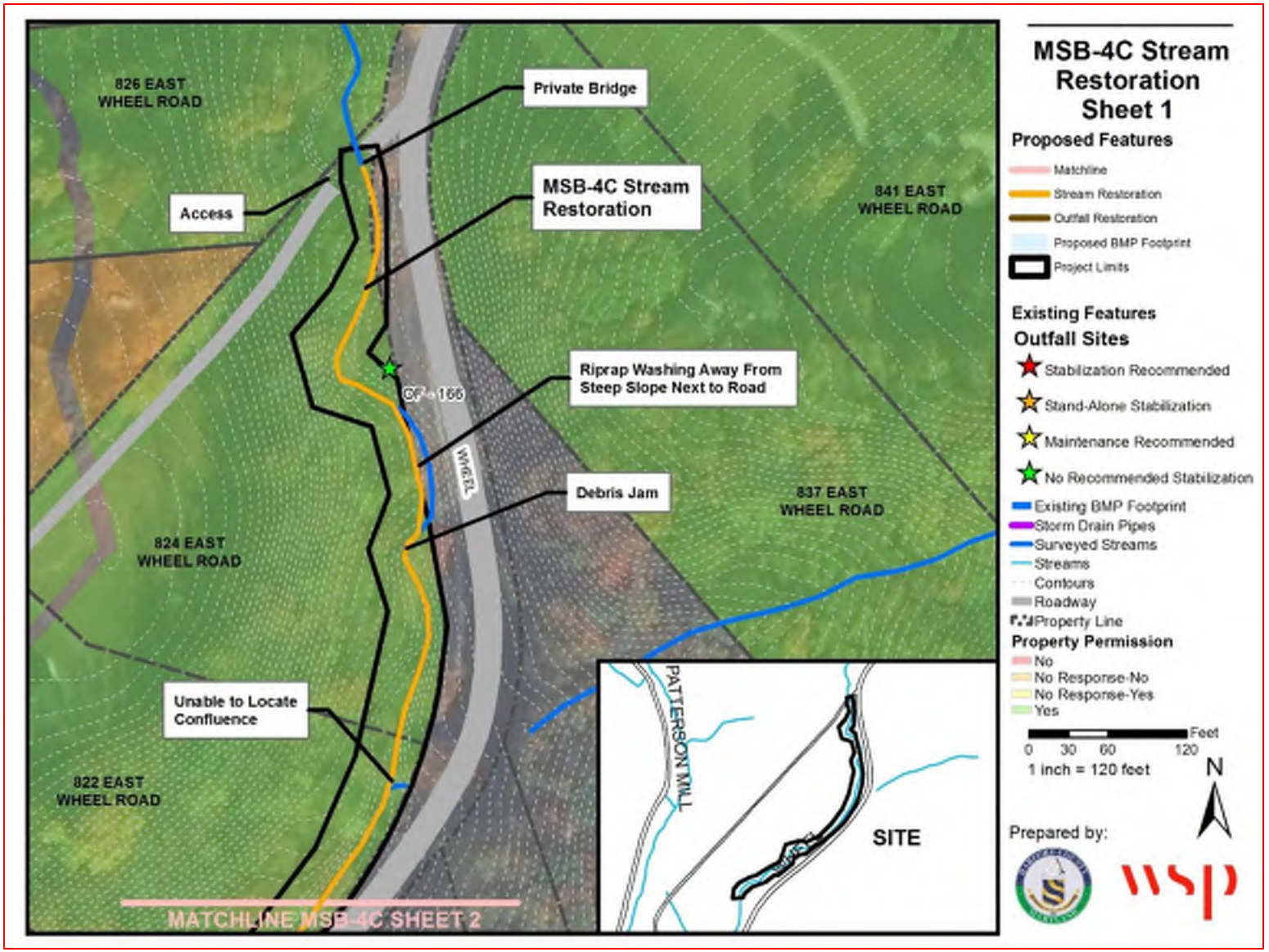

Figure C-33: Site Location and Proposed Project Plan for MSB-4C Stream Restoration (Sheet 1 of 2)

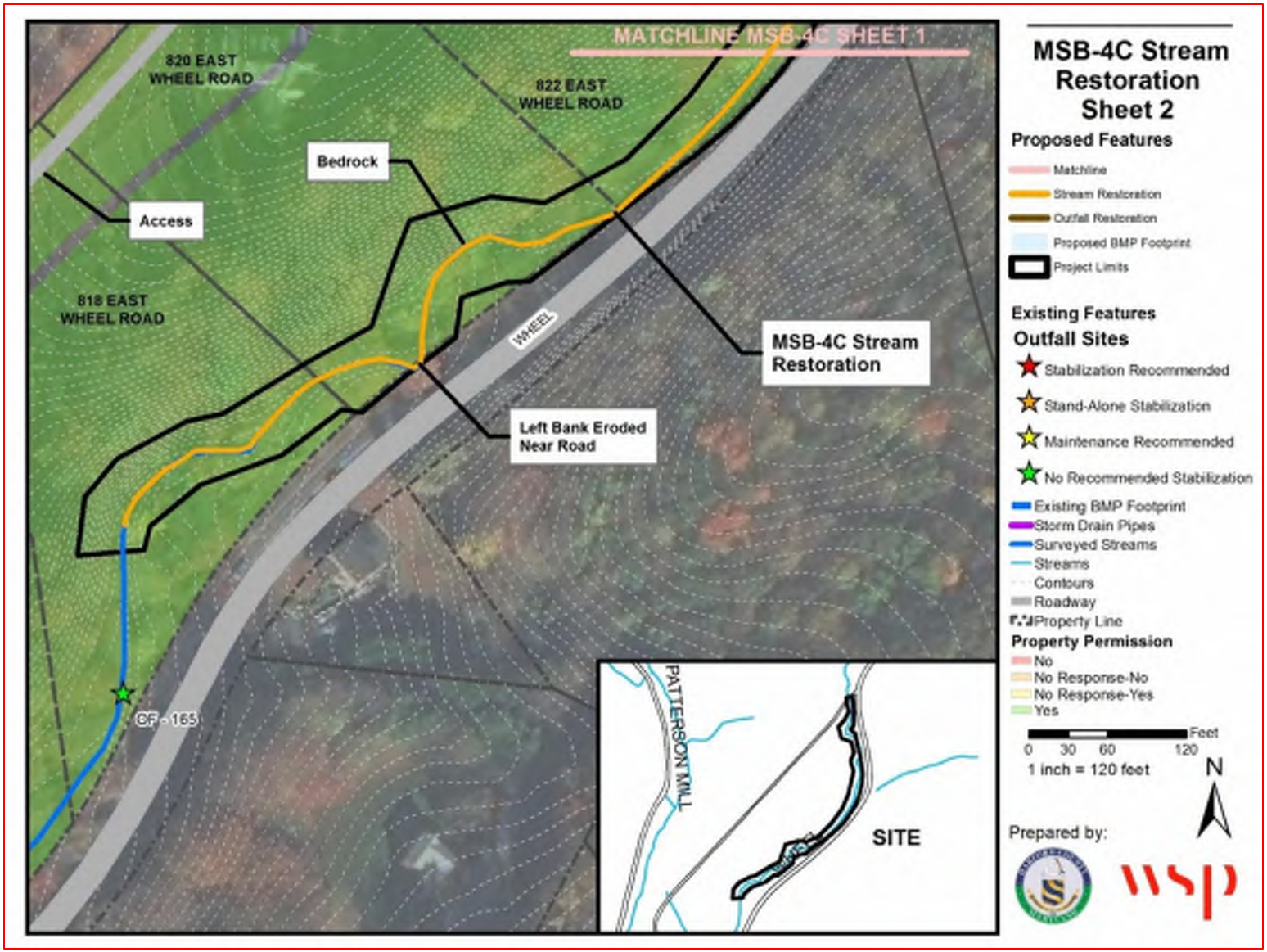

Figure C-34: Site Location and Proposed Project Plan for MSB-4C Stream Restoration (Sheet 2 of 2)

MSB-4D STREAM AND OUTFALL RESTORATION

Project Description	Restore 2,105 feet of stream and stabilize 100 feet of outfall channel • Outfall 44: Stabilize 10 feet • Outfall 51: Stabilize 90 feet
Location	Laurel Bush Road and East Wheel Road
Property Ownership	Three Private Properties
Length of Project	2,105 feet of stream restoration and 100 feet of outfall stabilization
Potential Impervious Acres Treated	64.15 Acres
Potential Load Reductions TP	143.14 lbs/yr
Potential Load Reductions TN	157.88 lbs/yr
Potential Load Reductions TSS	94,515 lbs/yr
Estimated Design/Construction Costs	$1,518,250 $23,667/impervious acres treated
Adjacent Projects	None

Site Description

MSB-4D is located northwest of East Wheel Rd and northeast of Laurel Bush Road. MSB-4D is 2,105 feet of proposed stream restoration and contains five outfalls, two of which are proposed for stabilization. The first 987 feet of MSB-4D is moderately eroded with average exposed bank heights of 5 feet. More severe erosion was seen in a few stream bends. In one instance, the stream bank was over 10 feet high, downstream of a cascading bedrock feature (Figure C-35, left).

Outfall 44 is located approximately 810 feet downstream and is a candidate for channel stabilization. The end of the pipe for this outfall could not be located; however, a hole was identified at the beginning of the outfall channel that is assumed to be the outfall (Figure C-35, right). This outfall is on the downstream side of the embankment for BMP SWM000066. The BMP has sediment covering the pond bottom, making it difficult to find the riser structure or dewatering device; however, Outfall 44 may be the outfall for the BMP. The outfall channel is eroding and will need to be stabilized.

Figure C-35: Moderate erosion on right bank with exposed bedrock in the stream channel (left); Hole assumed to be OF-44 (right).

The final 723 feet of stream has heavily eroded banks, with an average exposed bank height of 7 feet. Along with the severe erosion, there are 243 feet of inadequate buffer where lawns are mowed to the banks of the stream. There are two debris jams within MSB-4D, one being at the confluence of a tributary and the other in the middle of the stream. Lastly, there is a concrete dam with eroded banks and a scour hole (Figure C-36, left) and an exposed plastic sewer pipe (Figure C-36, right).

Figure C-36: Concrete dam with scour hole and eroded banks (left). Exposed plastic sewer pipe above bedrock on a moderately eroded bank (right).

Outfall 51 is located near the end of MSB-4D and is recommended for channel stabilization (Figure C-37, left). The flat outfall channel is lined with 30 feet of riprap before reaching a steep slope. Originally, the runoff was then piped approximately 100 feet down the steep slope by two 24-inch HDPE pipes. These pipes may have been installed and left in place during construction. At the original outfall of the two 24-inch HDPE pipes, the steep slope is lined with riprap before reaching the stream. Over time, flows eroded the channel under the 24-inch HDPE pipes, the pipes became disconnected and a new channel formed parallel to the original channel (Figure C-37, right). The outfall is approximately 35 feet higher than the stream bed.

Figure C-37: Outfall 51 (left); Outfall 51's eroding channel with broken HDPE pipe scattered throughout (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-4D, Main Stem*: 2,105 feet from Outfall 46 to 420 feet upstream of Outfall 167.
- **Outfall Stabilization**
  - *Outfall 44:* Replace end pipe and install riprap in channel
  - *Outfall 51:* Install drop structure to lower elevation of outfall, raise outfall channel, grade outfall channel to stream, and install riprap protection.
- Proposed project limits are shown in Figure C-38, Figure C-39, and Figure C-40.

Threats to Infrastructure

- The exposed sanitary sewer line with is exposed is threatened by continuous erosion in the channel undermining the surrounding soil stability and puncture by high flow debris.

Property Ownership

There are three private property owners along this reach and coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Hunter's Run Homeowner Association Inc.
- Private: HOA, Temple Hills Homeowner Association Inc.
- Private: 312 Wheel Road

Access

- Good Access at the corner of Point to Point Road and Laurel Bush Road for stream restoration.
- Good Access at 312 E. Wheel Road for stream restoration.

- Good Access at the storm drain easement between 313 Sedgefield Court and 315 Sedgefield Court for outfall stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-16. Two outfall stabilization projects, totaling 100 linear feet are recommended alongside 2,105 linear feet of stream restoration. The construction of 2,105 linear feet of stream restoration and 100 feet of outfall stabilization in this project will treat 62.13 impervious acres within the watershed. This treatment amount accounts for approximately 4.7% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,518,250 for the MSB-4D Stream and Outfall Restoration project. This cost estimate includes two outfall stabilization projects and one medium stream restoration project. The cost estimate for the project type is described in Appendix B. The cost estimate for the project is provided in Table C-17.

Table C-16: Summary of Improvements for MSB-4D Stream and Outfall Restoration

PROJECT TYPE	PROJECT NUMBER	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-44	6.3	2.6	10	0.1	-	-	-
	OF-51	17.43	6.48	90	0.90	-	-	-
Stream	MSB-4D	262.78	69.00	2,105	63.15	157.88	143.14	94,515
Total Credit/ Reductions				**2,205**	**64.15**	**157.88**	**143.14**	**94,515**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-17: Summary of Project Costs for MSB-4D Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-44	Medium	$50,000	Project	$50,000	
	OF-51	Large	$100,000	Project	$100,000	
Stream	MSB-4D	Medium	$650	L.F.	$1,368,250	$21,667
Total Costs					**$1,518,250**	**$23,667**

*Project cost divided by stream restoration impervious area treated

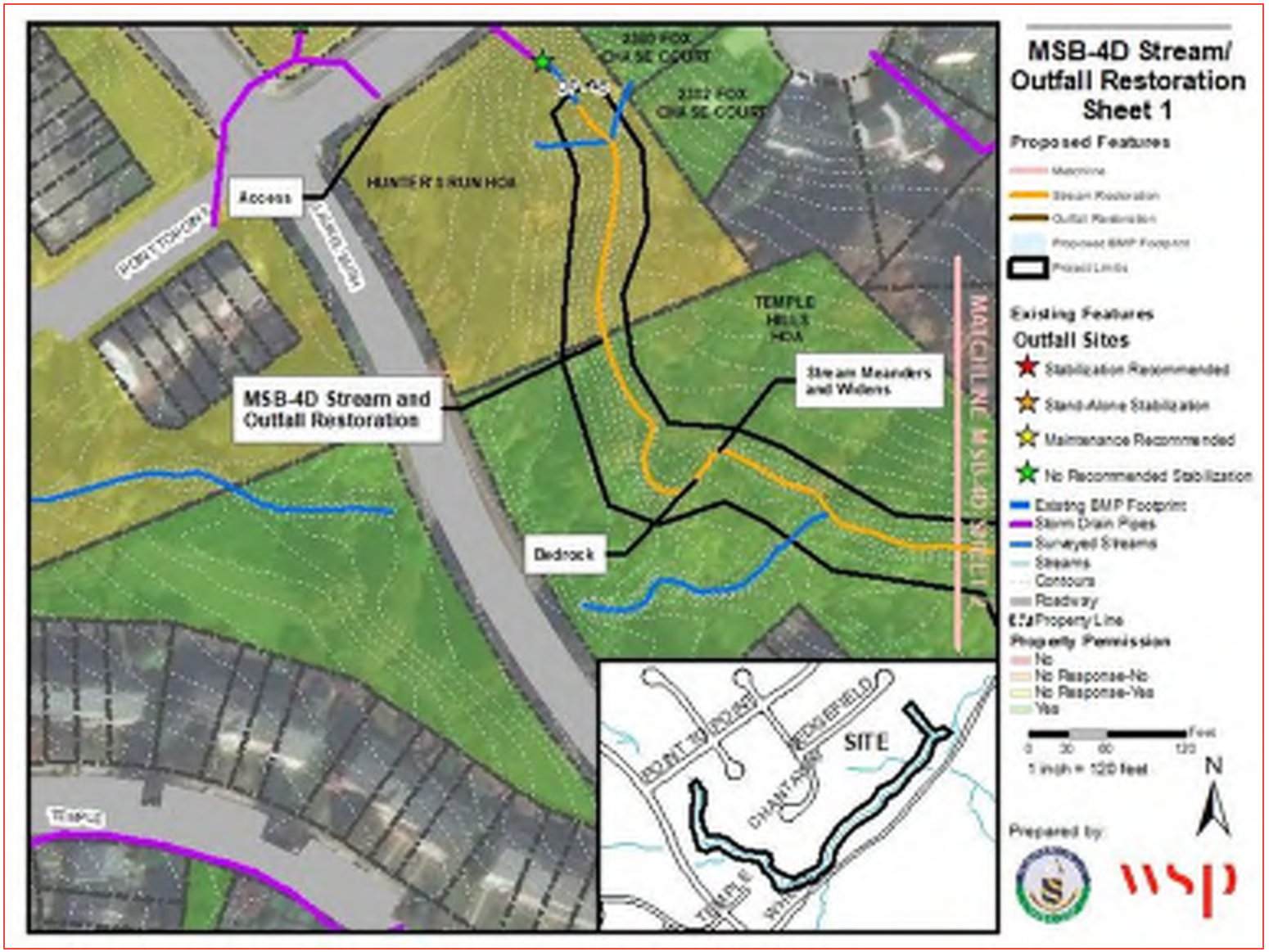

Figure C-38: Site Location and Proposed Project Plan for MSB-4D Stream and Outfall Restoration (Sheet 1 of 3)

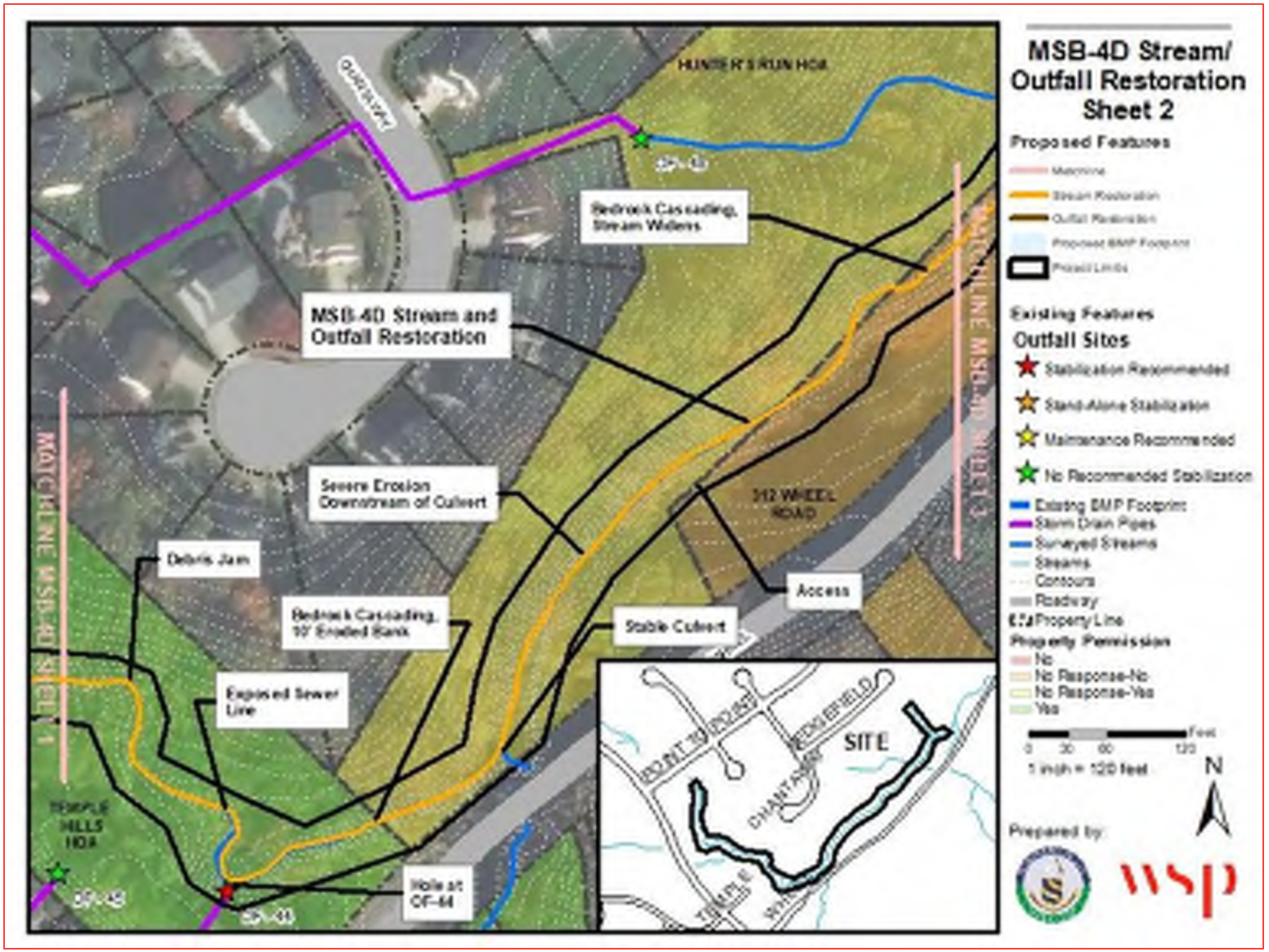

Figure C-39: Site Location and Proposed Project Plan for MSB-4D Stream and Outfall Restoration (Sheet 2 of 3)

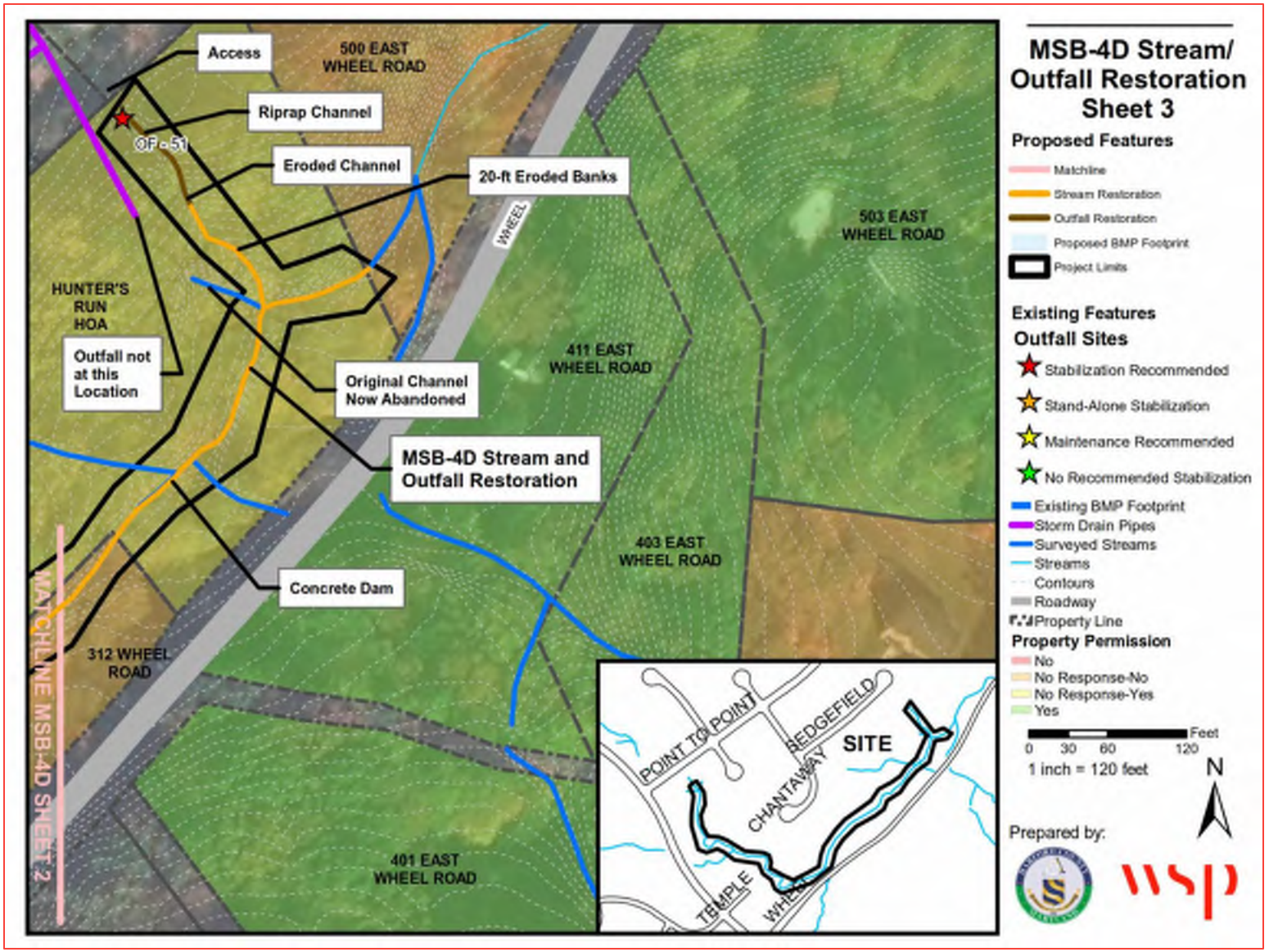

Figure C-40: Site Location and Proposed Project Plan for MSB-4D Stream and Outfall Restoration (Sheet 3 of 3)

MSB-4E STREAM AND OUTFALL RESTORATION

Project Description	Restore 3,325 feet of stream restoration and 12 feet of channel stabilization at Outfall 185
Location	Laurel Bush Road, North of Spruce Pine Road
Property Ownership	Three Private Properties
Length of Project	3,325 feet of stream restoration and 12 feet of outfall stabilization
Potential Impervious Acres Treated	99.87 Acres
Potential Load Reductions TP	226.11 lbs/yr
Potential Load Reductions TN	249.38 lbs/yr
Potential Load Reductions TSS	149,297 lbs/yr
Estimated Design/Construction Costs	$1,853,750 $18,562/impervious acres treated
Adjacent Projects	None

Site Description

MSB-4E is south of Lindsay Court and runs perpendicular to Laurel Bush Road. This project proposes 3,325 feet of stream restoration and the stabilization of outfall 185. The left and right banks are severely eroded for the entire length of the stream project with an average exposed bank height of 4 feet and in some areas, erosion is threatening a paved path (Figure C-41, left). Approximately, 900 feet of both banks have an inadequate buffer due to pasture and residential land use (Figure C-41, right).

Figure C-41: Severe erosion on the left bank's proximity to the paved path (left); Inadequate buffer on the right due to lawns (right)

BMP SWM000040 outfalls to the left bank of MSB-4E approximately 400 feet downstream of the start of the project and receives runoff from nearby neighborhoods. A gap in the embankment has been stabilized with geotextile material (Figure C-42). The outfall channel is approximately 100 feet long and is stable.

Figure C-42: BMP under construction.

A large debris jam has occurred approximately 1,200 feet downstream. Upstream of the debris jam, the stream has widened and is very shallow. Sediment and stone have accumulated behind the debris jam. The stream is narrower and deeper downstream of the debris jam (Figure C-43).

Figure C-43: Stream widening before debris jam constriction.

Outfall 185 is the outfall for an unnumbered BMP and is located northwest of Oat Grass Court. The outfall channel has eroded and caused undercutting of the outfall endwall (Figure C-44).

Figure C-44: Undercutting of Outfall 185 endwall.

Recommended Restoration Actions

- **Stream Restoration**
    - *MSB-4E*: 3,325 feet from Laurel Bush Road culvert to 77 feet upstream of the confluence with Lower Bynum Run

- **Outfall Stabilization**
    - Outfall 185: 12 feet of stabilization; raise the outfall channel, and install riprap protection
- Proposed project plans are shown in Figure C-45, Figure C-46, Figure C-47, Figure C-48, and Figure C-49.

Threats to Infrastructure

- There are currently 3 sanitary sewer crossings within the stream restoration limits.
- Recreation path crossing vulnerable to collapse with further bank erosion.

Property Ownership

There are multiple private property owners along this reach and coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

In addition, one of the outfalls is on MDOT SHA property. There is a potential partnering opportunity for this location.

- Public: MDOT SHA Property
- Private: HOA, Laurel Valley Homeowners Association Inc
- Private: LP, Toll MD VIII LP
- Private: HOA, Overview Estates Homeowners Association Inc

Access

- Good Access at HOA Open Space adjacent to 302 Spruce Pine Road for stream restoration.
- Good Access at BMP easement between 2756 Oat Grass Court and 2750 Oat Grass Court for stream restoration and outfall stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-18. One outfall stabilization project, totaling 12 linear feet is recommended alongside 3,325 linear feet of stream restoration. The construction of 3,325 linear feet of stream restoration and 12 feet of outfall stabilization in this project will treat 99.87 impervious acres within the watershed. This treatment amount accounts for approximately 7.6% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,853,750 for the MSB-4E Stream and Outfall Restoration project. This cost estimate includes one small outfall stabilization project as well as a large stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-19.

Table C-18: Summary of Improvements for MSB-4E Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)†	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-185	9.6	0.13	12	0.12	-	-	-
Stream	MSB-4E	415.68	105.06	3,325	99.75	249.38	226.11	149,297
Total Credit/ Reductions				**3,337**	**99.87**	**249.38**	**226.11**	**149,297**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-19: Summary of Project Costs for MSB-4E Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-185	Small	$25,000	Project	$25,000	
Stream	MSB-4E	Large	$550	L.F.	$1,828,750	$18,333
Total Costs					**$1,853,750**	**$18,562**

*Project cost divided by stream restoration impervious area treated

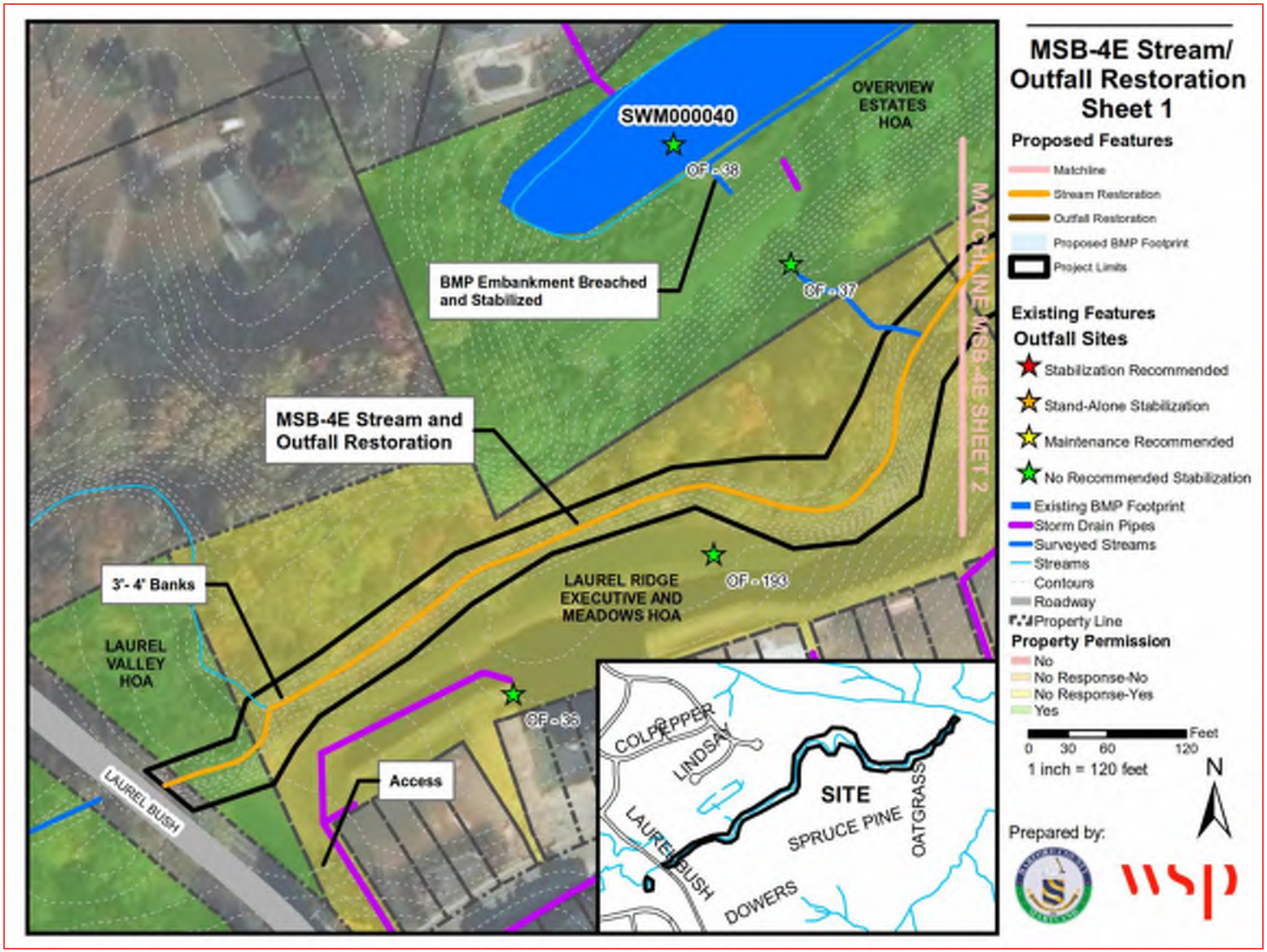

Figure C-45: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 1 of 5)

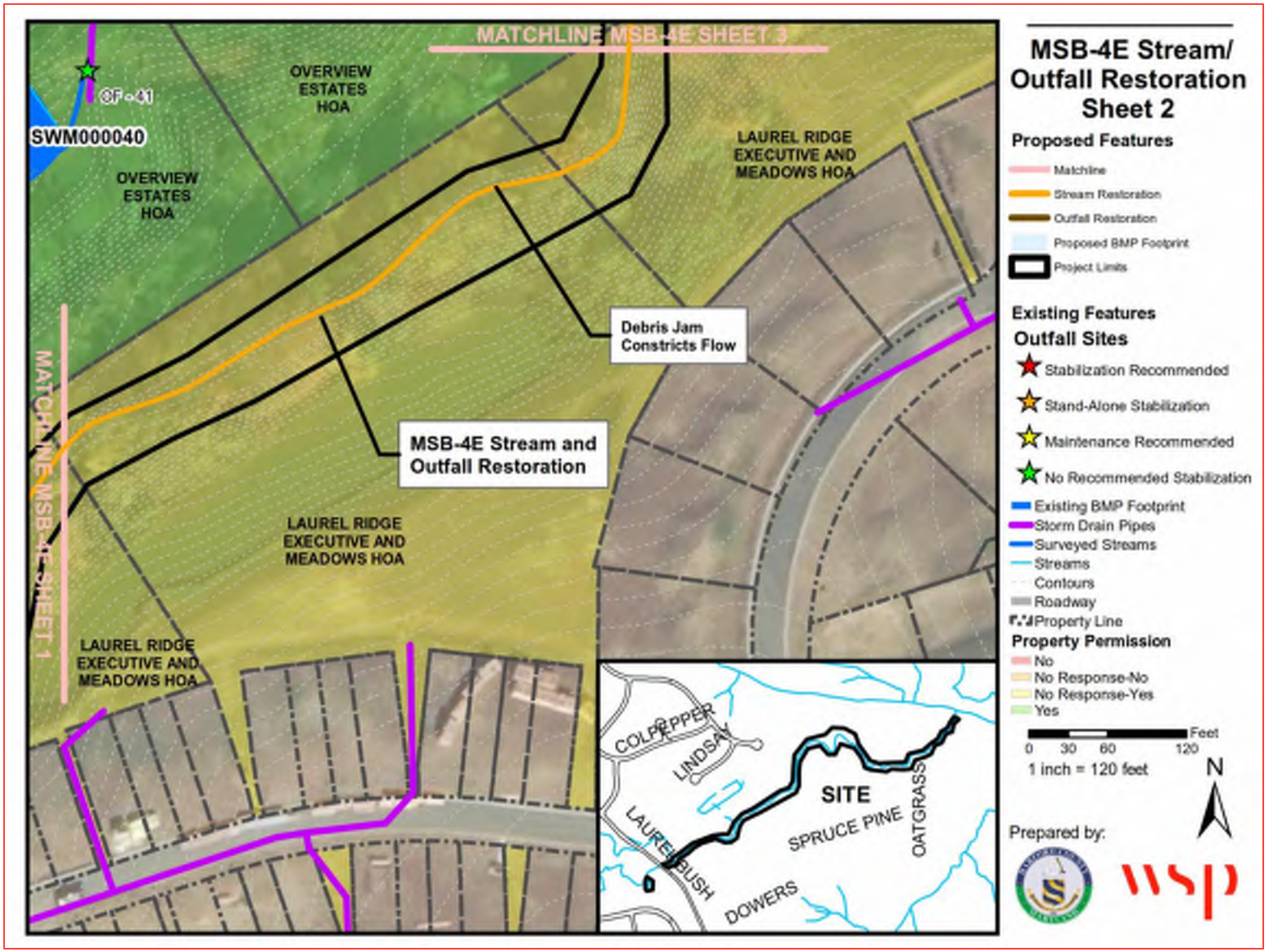

Figure C-46: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 2 of 5)

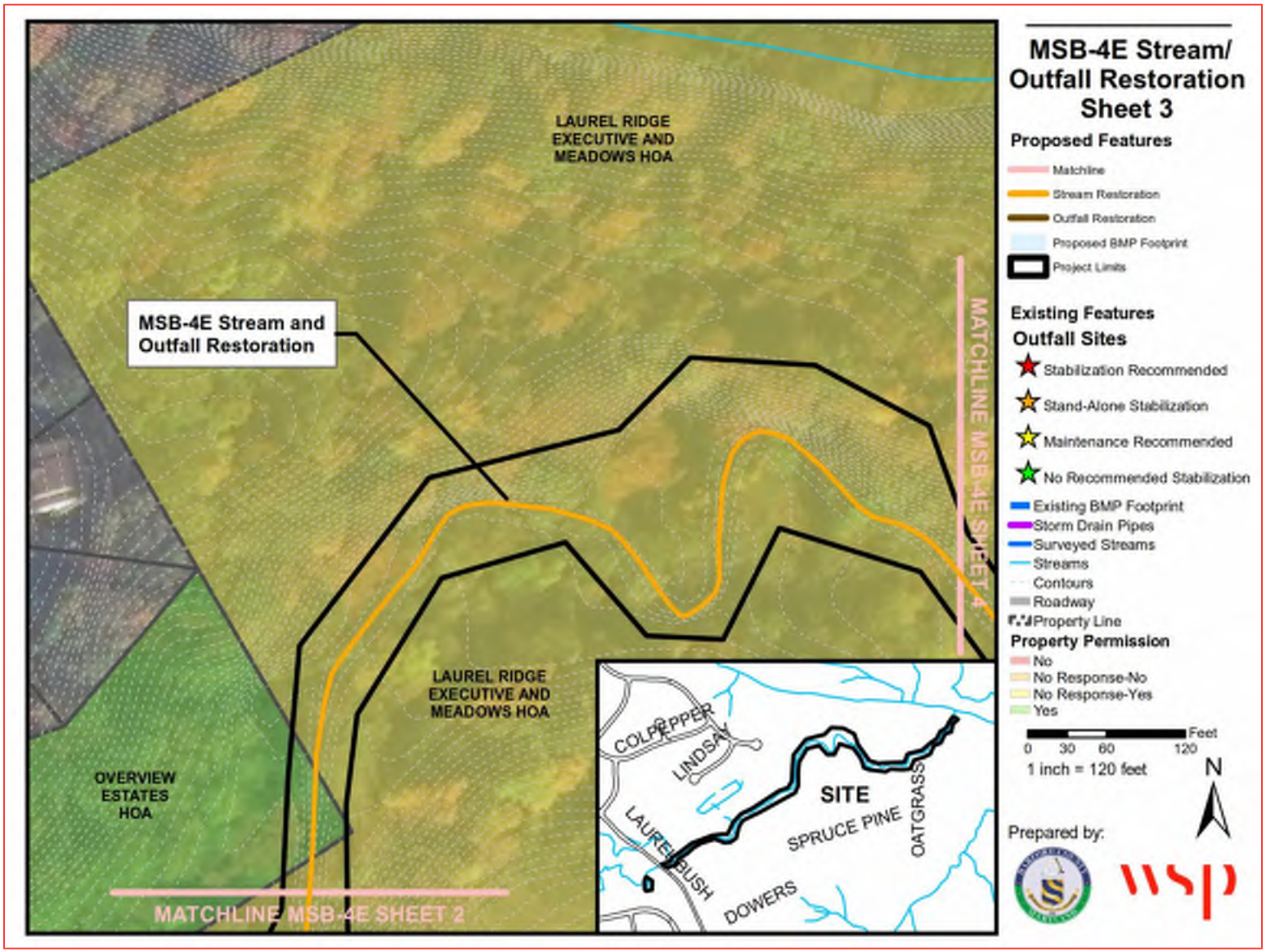

Figure C-47: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 3 of 5)

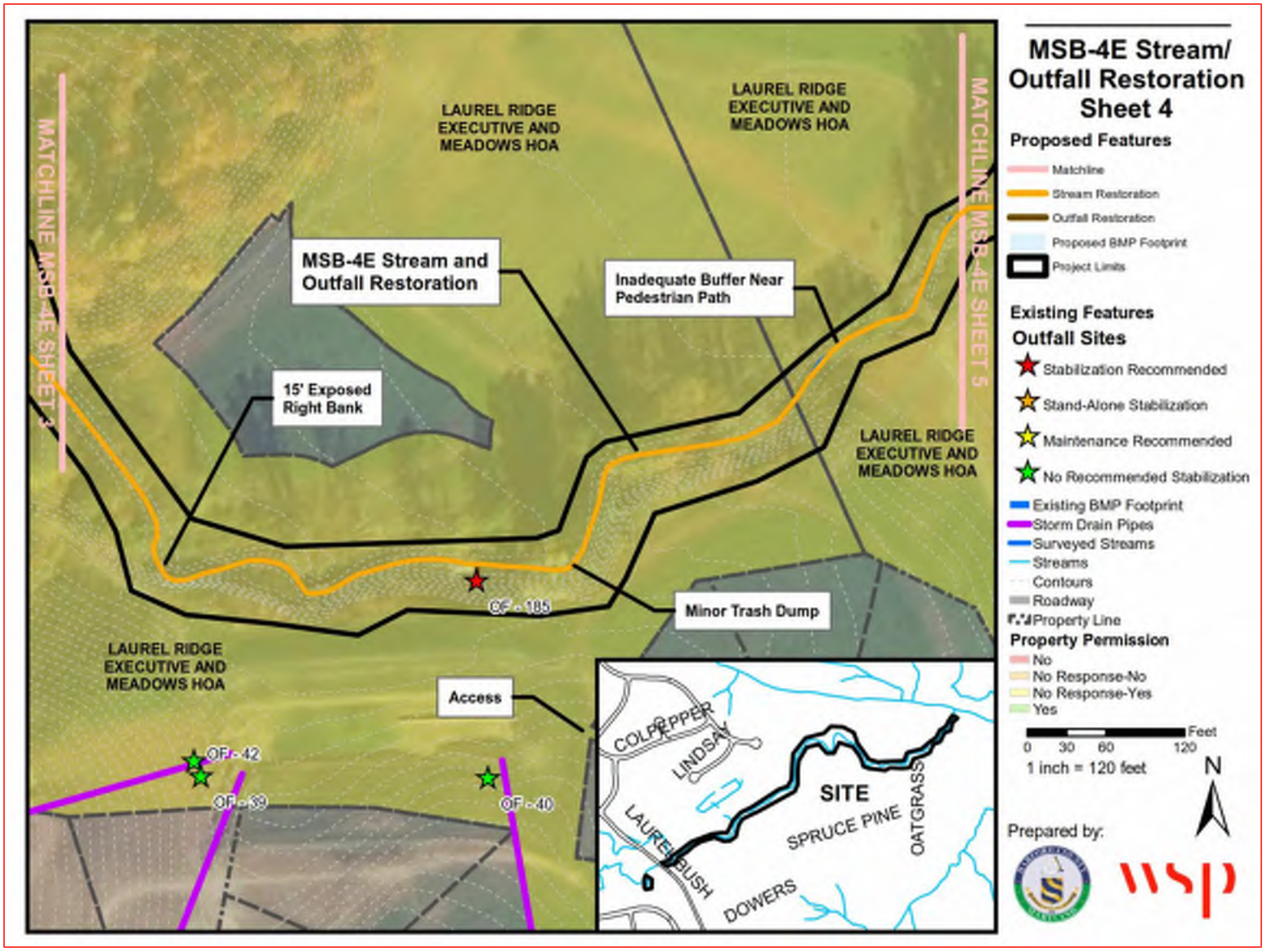

Figure C-48: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 4 of 5)

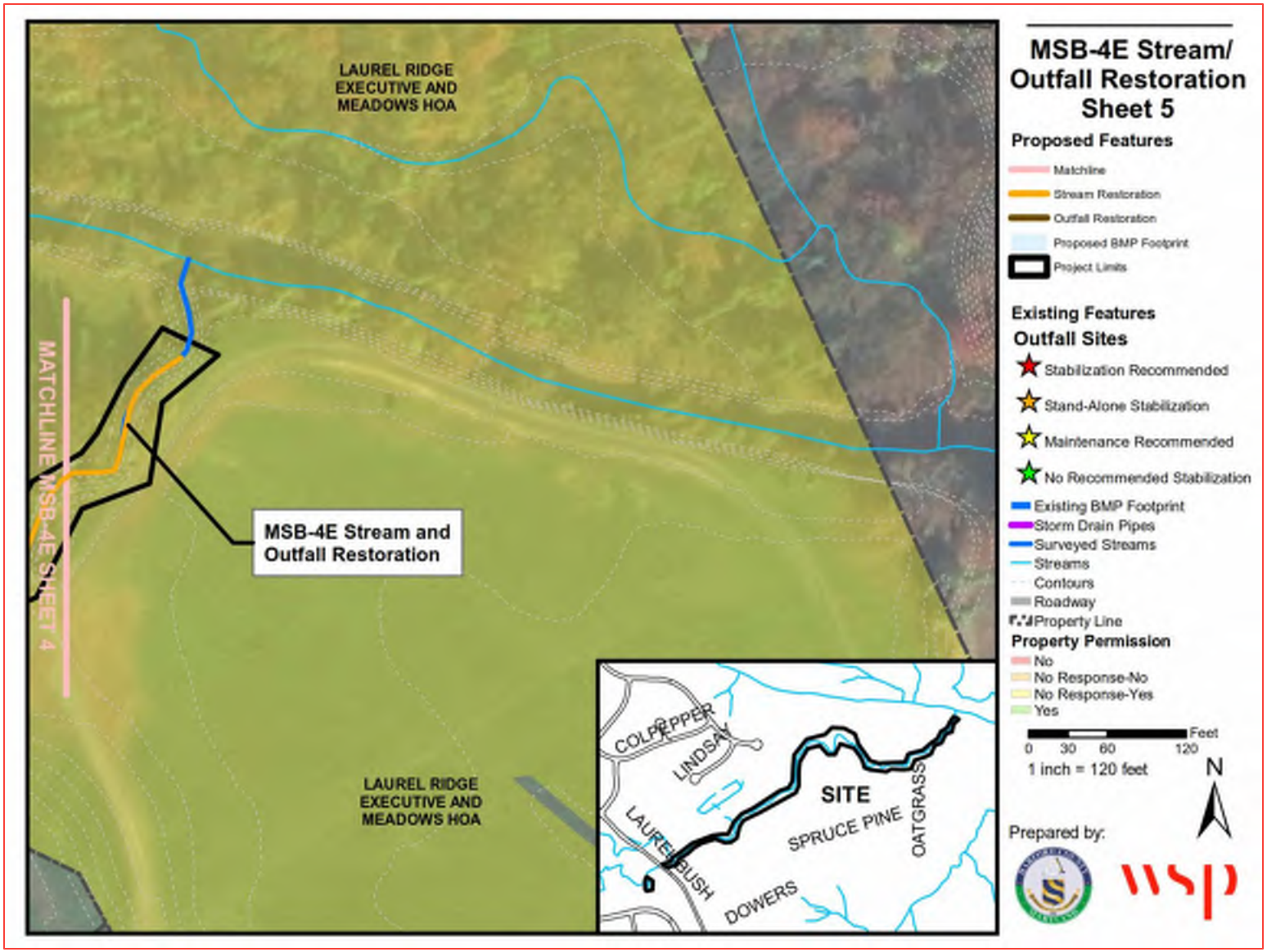

Figure C-49: Site Location and Proposed Project Plan for MSB-4E Stream and Outfall Restoration (Sheet 5 of 5)

MSB-4F OUTFALL RESTORATION

Project Description	Stabilize 96 feet of channel at Outfall 35
Location	Between 214 Laurentum Parkway and 216 Laurentum Parkway
Property Ownership	Two private properties
Length of Project	96 feet of outfall stabilization
Potential Impervious Acres Treated	0.96 Acres
Potential Load Reductions TP	N/A
Potential Load Reductions TN	N/A
Potential Load Reductions TSS	N/A
Estimated Design/Construction Costs	$25,000 $26,042/impervious acres treated
Adjacent Projects	N/A

Site Description

The upstream limit of MSB-4F is located at the northeast corner of 214 Laurentum Parkway, a private residence. It proposes a restoration of Outfall 35 which receives discharge from the northeastern portion of the Box Hill community. The outfall consists of a 15-inch diameter CMP pipe and a winged, plastic endwall. Both the outfall pipe and endwall are in good condition (Figure C-50) but are suspended 5 feet above the channel bed. There is minimal outfall channel protection comprised of riprap and 5 feet of exposed bank extend 80 feet from the outfall structure (Figure C-51, left). Erosion has exposed bedrock within the outfall channel. The eroded banks continue approximately 80 feet until the channel's confluence with its receiving stream (Figure C-51, right).

Figure C-50: View of Outfall 35 showing distance from the top and bottom of bank (left); View of outfall height above channel bottom (right)

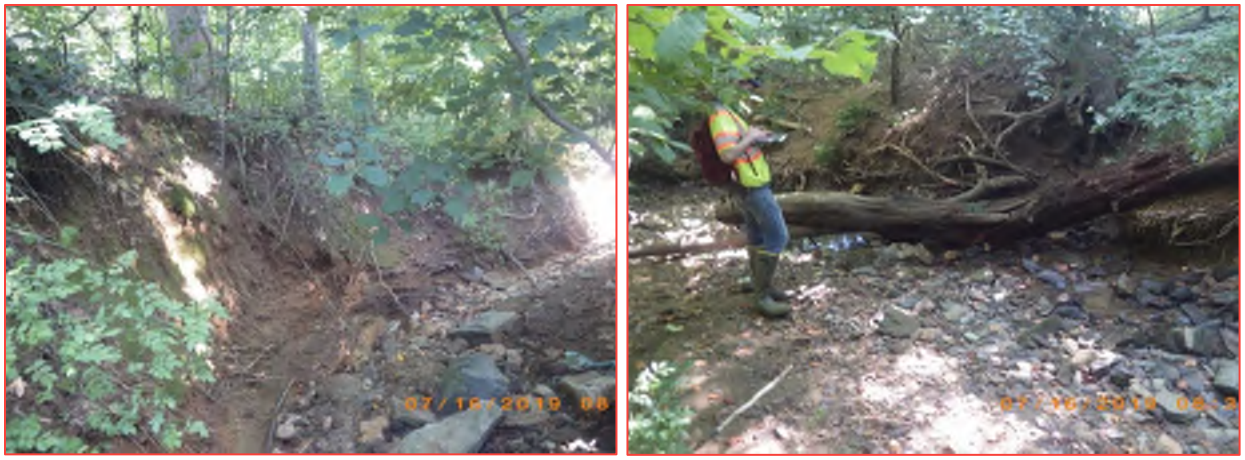

Figure C-51: Average 5-foot high exposed banks from Outfall 35 (left); Outfall 35 confluence with stream channel (right).

Recommended Restoration Actions

- **Outfall Stabilization**
    - *Outfalls 35:* Remove metal apron, partially fill in channel, install plunge pool, grade outfall channel and line with riprap protection.
- Proposed project limits are shown in Figure C-52.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are two private property owners along this reach and coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the outfall channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Laurel Valley Homeowners Association Inc.
- Private: 214 Laurentum Parkway
- Private: 216 Laurentum Parkway

Access

- Difficult Access due to private fence between 214 Laurentum Parkway and 216 Laurentum Parkway outfall restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-20. The construction of 96 linear feet of outfall stabilization in this project will treat 0.96 impervious acres within the watershed. This treatment amount accounts for approximately 0.07% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $25,000 for the MSB-4F Outfall Restoration project. This cost estimate includes one small outfall stabilization project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-21.

Table C-20: Summary of Improvements for MSB-4F Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-35	7.3	2.60	96	0.96	-	-	-
Stream								
Total Credit/ Reductions				**96**	**0.96**			

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-21: Summary of Project Costs for MSB-4F Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-35	Small	$25,000	Project	$25,000	
Stream						
Total Costs					**$25,000**	**$26,042**

*Project cost divided by stream restoration impervious area treated

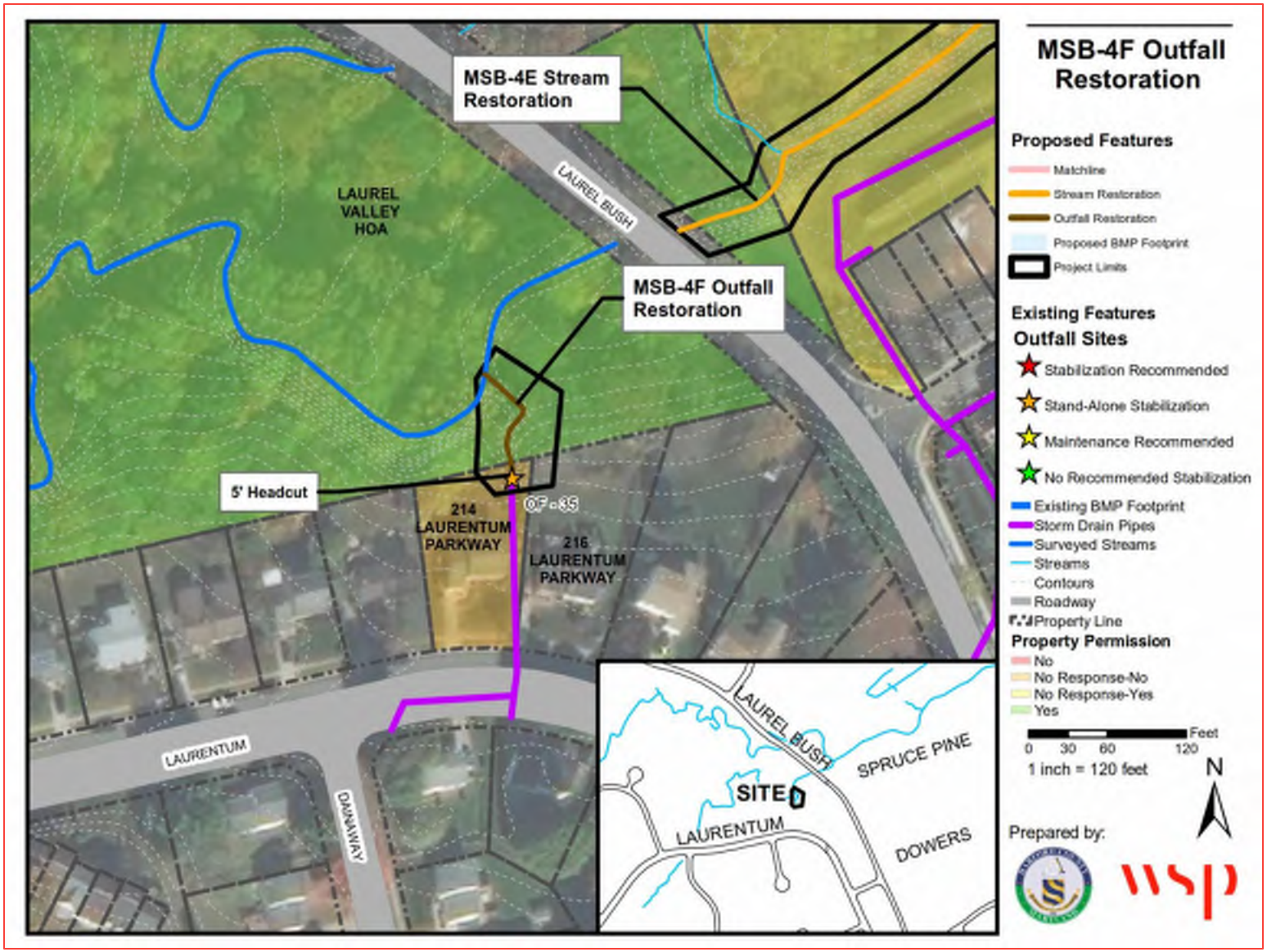

Figure C-52: Site Location and Proposed Project Plan for MSB-4F Outfall Restoration

MSB-4G STREAM AND OUTFALL RESTORATION

Project Description	Restore 160 feet of stream restoration and 30 feet of channel stabilization at Outfall 65
Location	Saddle Ridge HOA open space south of Hurdle Court
Property Ownership	No private properties
Length of Project	160 feet of stream restoration and 30 feet of outfall stabilization
Potential Impervious Acres Treated	5.1 Acres
Potential Load Reductions TP	10.88 lbs/yr
Potential Load Reductions TN	12.00 lbs/yr
Potential Load Reductions TSS	7,184 lbs/yr
Estimated Design/Construction Costs	$170,000 $33,333/impervious acres treated
Adjacent Projects	N/A

Site Description

MSB-4G is located between 2210 and 2212 Gelding Way in a designated open space area owned by the Saddle Ridge Homeowner's Association. It proposes a restoration of Outfall 65 which receives discharge from the central portion of the Saddle Ridge community. The outfall consists of a 36-inch diameter CMP pipe and a metal end section. Both the outfall pipe and end section are in good condition (Figure C-53, left). The outfall structure is located at the end of a series of three drop structures and adjacent to a shallow, residential BMP (Figure C-53, right). There is a water quality basin at the outfall.

Figure C-53: View of 3 drop structures to Outfall 65 (left); Adjacent water quality basin to Outfall 65 (right)

There is 25 feet of riprap channel protection immediately downstream of the outfall structure and upstream of a 7-foot headcut (Figure C-54, left). The riprap and geotextile has been disturbed upstream and downstream of the headcut and banks are exposed as a result. The outfall channel converges with the stream channel 160 feet downstream of the 7-foot headcut. There is an additional 2-foot headcut, 45 feet downstream of the 7-foot headcut. The channel following the 2-foot headcut splits into two separate,

parallel lengths consisting of braided channels to the left and a new and eroded channel to the right. The new, eroded channel lacks channel protection (Figure C-54, right).

Figure C-54: 7 ft high headcut with exposed geotextile and soil (left); View of exposed geotextile downstream of large headcut moving towards the new, eroded, channel to the right (right).

Recommended Restoration Actions

- **Stream Restoration**
    - MSB-4G: Grade channel towards stream and line with riprap protection.
- **Outfall Maintenance**
    - *Outfalls 65:* Replace drop structure with one that is 7 feet deep and install plunge pool.
- Proposed project limits are shown in Figure C-55.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are is one private homeowner's association along this reach and coordinating buy in from the property owner at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the stream and outfall channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Saddle Ridge Homeowners Association Inc.

Access

- Difficult Access at Saddle Ridge HOA open space south of Hurdle Court for outfall stabilization and stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-22. The construction of 160 linear feet of stream restoration and 30 feet of outfall stabilization in this project will treat 5.10 impervious acres within the watershed. This treatment amount accounts for approximately 0.34% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $170,000 for the MSB-4G Stream and Outfall Restoration project. This cost estimate includes one medium outfall stabilization project and one small stream restoration project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-23 .

Table C-22: Summary of Improvements for MSB-4G Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-65	7.5	3.29	30	0.30	-	-	-
Stream	MSB-4G	8.0	3.31	160	4.8	12.00	10.88	7,184
Total Credit/ Reductions				**190**	**5.1**	**12.00**	**10.88**	**7,184**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-23: Summary of Project Costs for MSB-4G Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-65	Medium	$50,000	Project	$50,000	
Stream	MSB-4G	Small	$750	L.F.	$120,000	
Total Costs					**$170,000**	**$33,333**

*Project cost divided by stream restoration impervious area treated

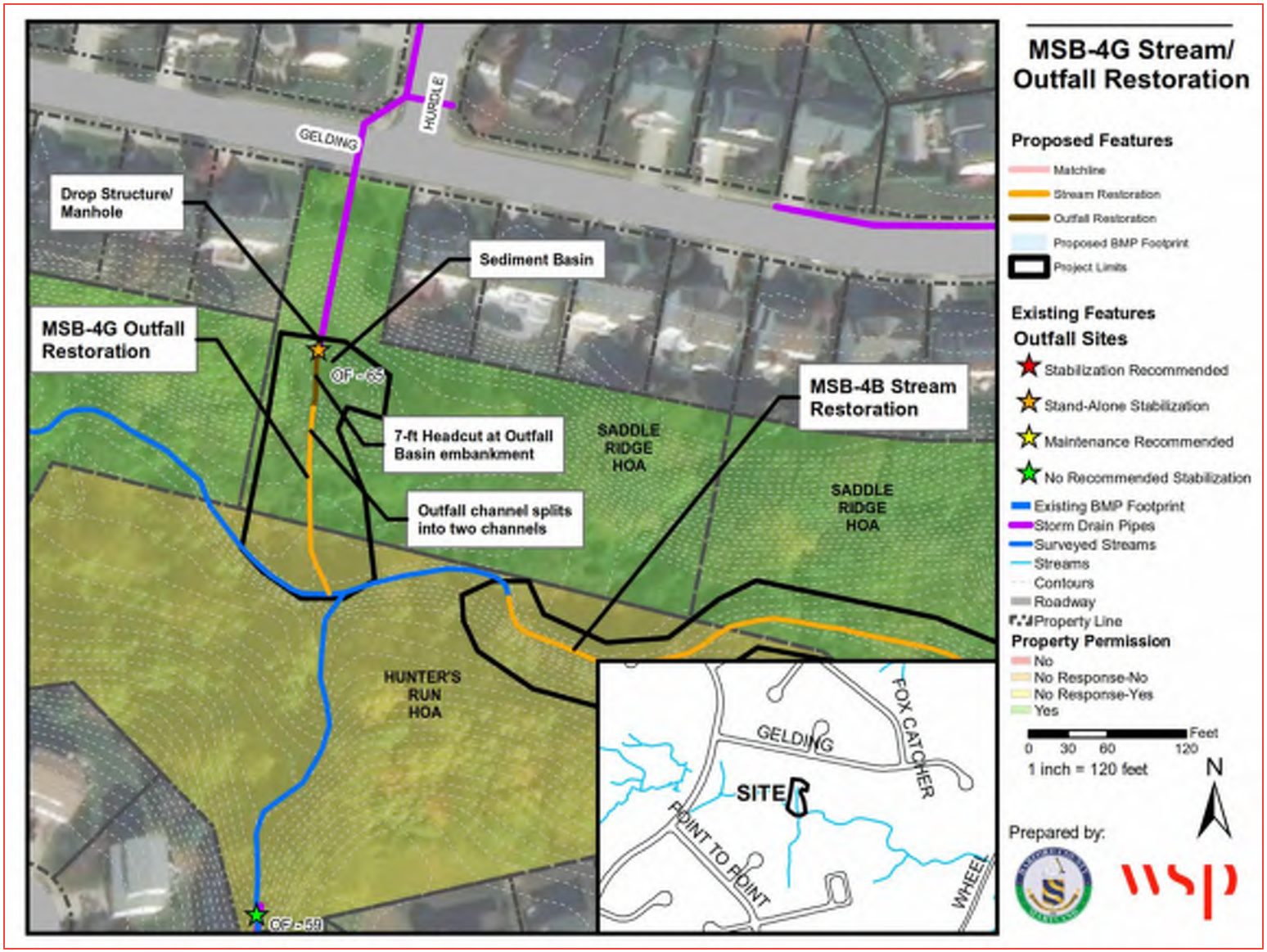

Figure C-55: Site Location and Proposed Project Plan for MSB-4G Stream and Outfall Restoration

MSB-5A STREAM RESTORATION

Project Description	Restore 2,058 feet of stream restoration
Location	Starmount Lane, North of Echo Court
Property Ownership	Four Private Properties
Length of Project	2,058 feet of stream restoration
Potential Impervious Acres Treated	61.74 Acres
Potential Load Reductions TP	139.94 lbs/yr
Potential Load Reductions TN	154.35 lbs/yr
Potential Load Reductions TSS	92,404 lbs/yr
Estimated Design/Construction Costs	$1,337,700 $21,667/impervious acres treated
Adjacent Projects	None

Site Description

MSB-5A is located southwest of Redfield Road and northwest of Brierhill Estates Drive. This project area includes 2,058 feet of stream restoration. The first 300 feet of erosion is moderate and has an average exposed bank height of 5 feet. The remaining length of stream has bank heights that vary from 1 to 3 feet high (Figure C-56). Multiple debris jams provide grade control in the middle of this stream reach.

Figure C-56: Moderate erosion with 2-foot banks (left) and 1-foot banks (right)

Approximately 900 feet downstream of the beginning of the project, the outfall channel for Outfall 116 ties in with the stream. Though the structure of outfall 116 and approximately 20 feet of channel protection is in good condition (Figure C-57, left), the remaining outfall channel is experiencing moderate erosion with an average exposed bank height of 6 feet. There is bedrock in the eroded outfall channel (Figure C-57, right).

Figure C-57: Outfall 116 structure (left) and channel stabilization of 6-foot tall exposed banks with exposed bedrock (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-5A:* 2,058 feet from behind 1421 Redfield Road to Starmount Lane.
- Proposed project plans are shown in Figure C-58, Figure C-59, and Figure C-60.

Threats to Infrastructure

- No current threat to infrastructure within the project area.

Property Ownership

There are multiple private property owners along this reach and coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, The Village of Scots Fancy Homeowners Association Inc.
- Private: HOA, Brierhill Estates Homeowners Association Inc.
- Private: HOA, Foundation Glen Homeowners Association Inc.
- Private: 1405 Loch Carron Way

Access

- Moderate Access between 1425 and 1419 Redfield Road at a sanitary sewer easement for stream restoration.
- Moderate Access between 1407 and 1409 Loch Carron at a stormwater easement for stream restoration and Outfall stabilization.
- Difficult Access at the Open Space south of 1214 Starmount Lane for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-24. This project recommends 2,058 linear feet of stream restoration. The construction of 2,058 linear feet of stream in this project will treat 61.74 impervious acres within the watershed. This treatment amount accounts for approximately 4.7% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,337,700 for the MSB-5A Stream Restoration project. This cost estimate includes a medium stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-25.

Table C-24: Summary of Improvements for MSB-5A Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES)†	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-5A	24.23	3.91	2,058	61.74	154.35	139.94	92,404
Total Credit/ Reductions				**2,058**	**61.74**	**154.35**	**139.94**	**92,404**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-25: Summary of Project Costs for MSB-5A Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-5A	Medium	$650	L.F.	$1,337,700	$21,667
Total Costs					**$1,337,700**	**$21,667**

*Project cost divided by stream restoration impervious area treated

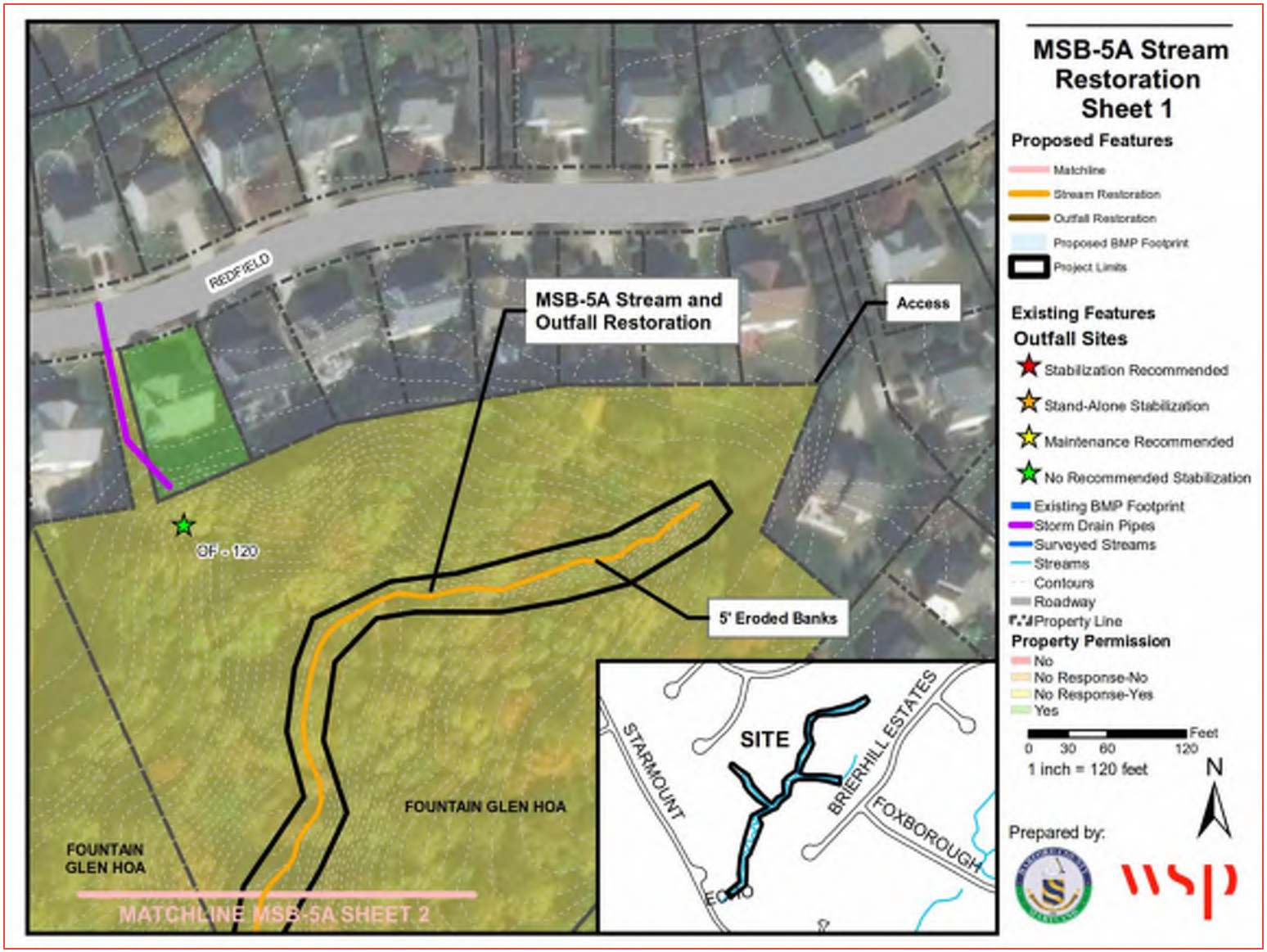

Figure C-58: Site Location and Proposed Project Plan for MSB-5A Stream and Outfall Restoration (Sheet 1 of 3)

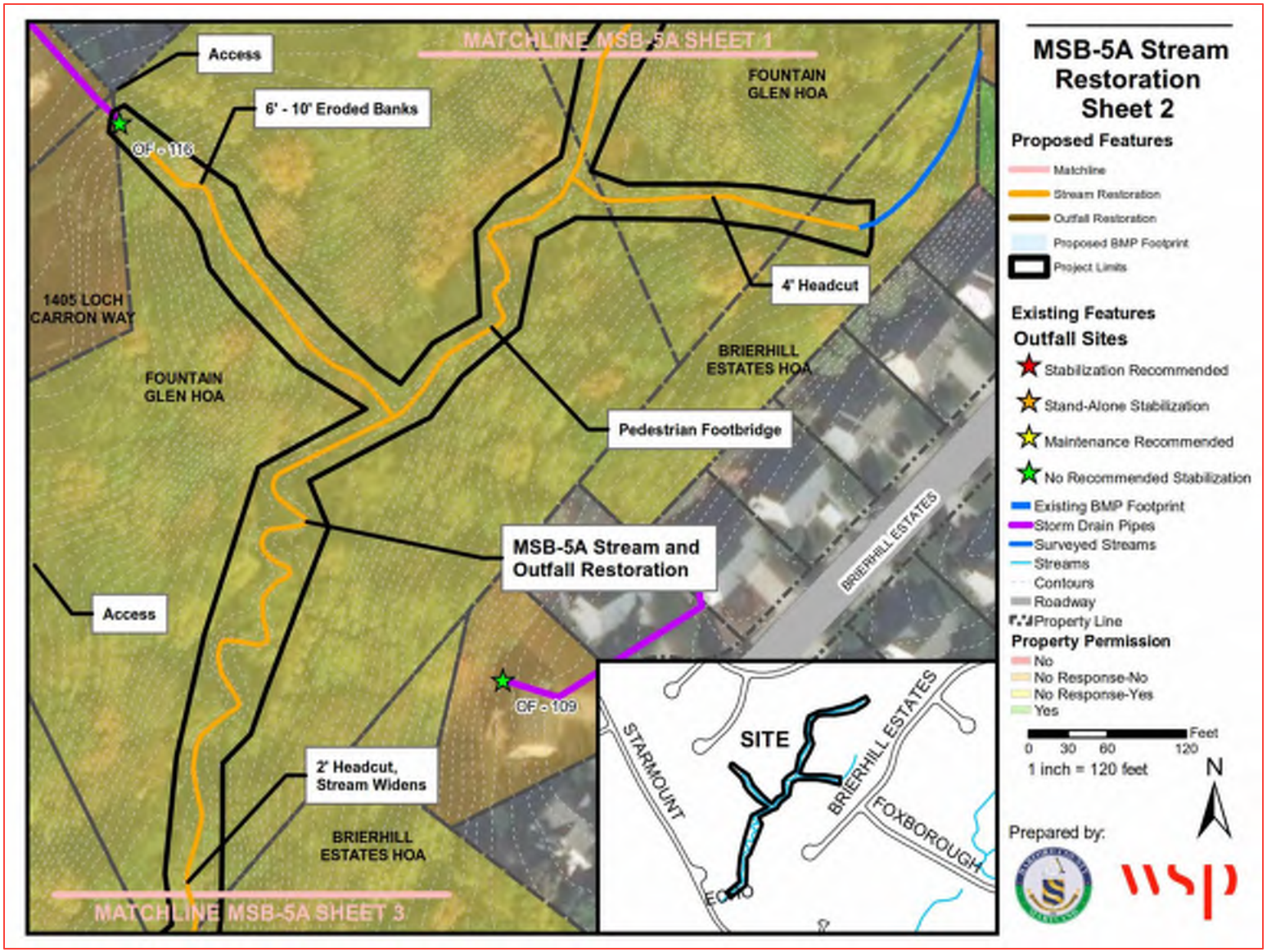

Figure C-59: Site Location and Proposed Project Plan for MSB-5A Stream and Outfall Restoration (Sheet 2 of 3)

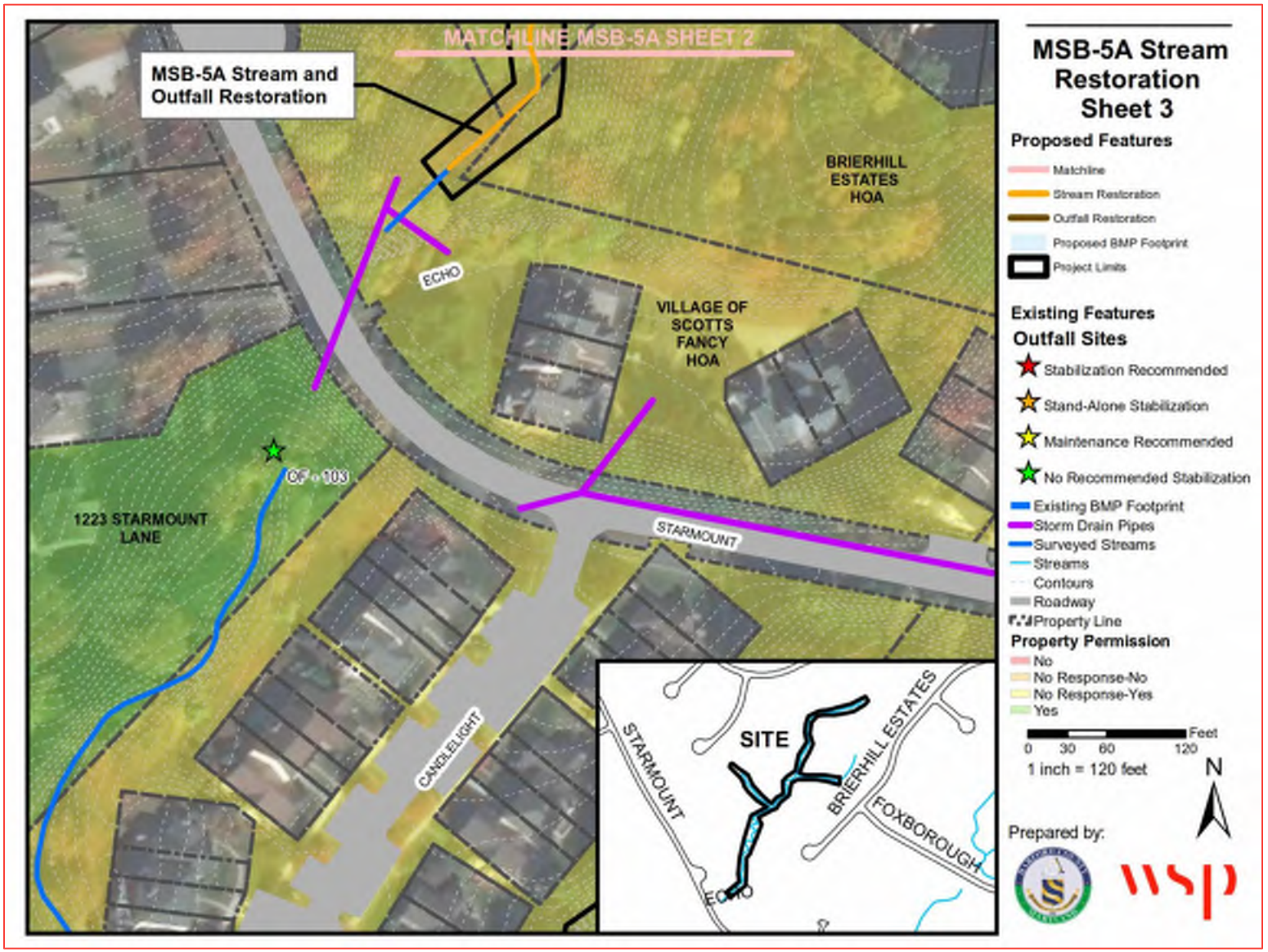

Figure C-60: Site Location and Proposed Project Plan for MSB-5A Stream and Outfall Restoration (Sheet 3 of 3)

MSB-5B STREAM RESTORATION

Project Description	Restore 1,327 feet of stream restoration
Location	Cambry Drive and Foxborough Drive
Property Ownership	One Private Property
Length of Project	1,327 feet of stream restoration
Potential Impervious Acres Treated	39.80 Acres
Potential Load Reductions TP	90.22 lbs/yr
Potential Load Reductions TN	99.51 lbs/yr
Potential Load Reductions TSS	59,571 lbs/yr
Estimated Design/Construction Costs	$872,550 $21,923/impervious acres treated
Adjacent Projects	None

Site Description

Project MSB-5B is located between Valbrook Court S. to the north and Merryhill Court to the south. This project proposes 1,327 feet of stream restoration and maintenance on two outfalls. The entire 1,327 feet of the right bank contains moderate severity bank erosion. (Figure C-61, left), The stream channel in this area has experienced widening (Figure C-61, right).

Figure C-61: Left bank severe erosion section with 15-foot average exposed bank height (left); Moderate severity erosion with 3-foot average exposed bank height at downstream limits of project MSB-5B (right).

Outfall 124 is at the headwater of the stream and conveys flow from neighborhoods east of Foxborough Drive. The outfall is a 30-inch diameter RCP pipe with an endwall (Figure C-62, left). The structure is in good condition; however, a large earth and tree debris jam is blocking the flow from the rest of the outfall channel and stream (Figure C-62, right).

Figure C-62: Looking at Endwall for Outfall 124 (left); Looking downstream of Outfall 124 at large debris jam (right).

Outfall 125 is also at the headwater of the stream and conveys flows from north of Cambry Drive. The outfall is a 30-inch diameter metal pipe discharging from a concrete headwall into a 2 feet deep channel (Figure C-63, left). The bed of the channel is armored with gabion baskets and the sides of the channel are earthen. Downstream, multiple debris jams have fallen across the channel preventing positive flow towards the stream (Figure C-63, right). The channels for outfall's 125 and 124 converge approximately 140 feet downstream of outfall 125.

Figure C-63: Upstream view of outfall 125 structure and immediate channel protection (left); Downstream view of outfall 125 channel with debris jam in foreground and background (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-5B*: 1,327 feet from 74 feet from Outfall 125 to 233 feet upstream of Outfall 115.
- **Outfall Maintenance**
  - *Outfall 124:* Remove tree debris jam to restore positive grade and repair riprap channel

- *Outfall 125:* Remove tree debris jam to restore positive grade
- Proposed project plans are shown in Figure C-64 and Figure C-65.

Threats to Infrastructure

- There is a sanitary sewer pipe crossing near the upstream limit of the project area. The sanitary line continues to follow the general profile of the stream through the rest of the stream length. Continued erosion throughout this area leaves the sanitary line vulnerable to future exposure.

Property Ownership

There is only private property owner along this reach. Coordinating buy in from property owners at the beginning of the project will help limit major changes to the project later in design process. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Foxborough Farms Homeowners Association No. 3 Inc.

Access

- Good Access at the Open Space on Foxborough Drive north of Merry Hill Court for stream restoration and Outfall 124 maintenance.
- Moderate Access at the Open Space on Merry Hill Court, west of 1350 Merry Hill Court for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-26. The construction of 1,327 linear feet of stream restoration in this project will treat 39.8 impervious acres within the watershed. This treatment amount accounts for approximately 3.0% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $872,550 for the MSB-5B Stream Restoration project. This cost estimate includes two small outfall maintenance projects as well as a medium stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-27.

Table C-26: Summary of Improvements for MSB-5B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance	OF-124	-	-	-	-	-	-	-
	OF-125	-	-	-	-	-	-	-
Outfall								
Stream	MSB-5B	96.10	24.61	1,327	39.80	99.51	90.22	59,571
Total Credit/ Reductions				**1,327**	**39.80**	**99.51**	**90.22**	**59,571**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-27: Summary of Project Costs for MSB-5B Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance	OF-124	Small	$5,000	Project	$5,000	
	OF-125	Small	$5,000	Project	$5,000	
Outfall						
Stream	MSB-5B	Medium	$650	L.F.	$862,550	$21,672
Total Costs					**$872,550**	**$21,923**

*Project cost divided by stream restoration impervious area treated

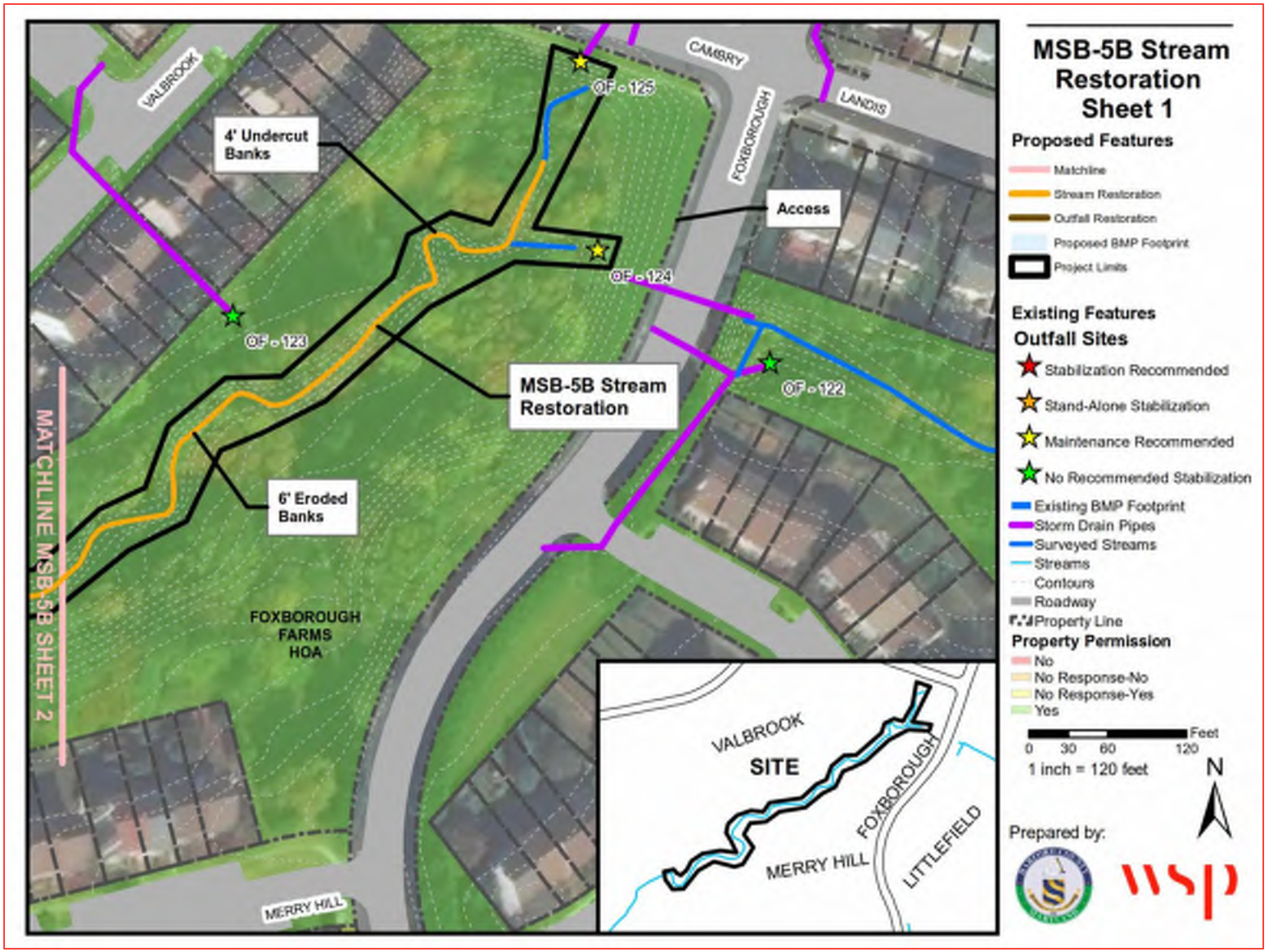

Figure C-64: Site Location and Proposed Project Plan for MSB-5B Stream Restoration (Sheet 1 of 2)

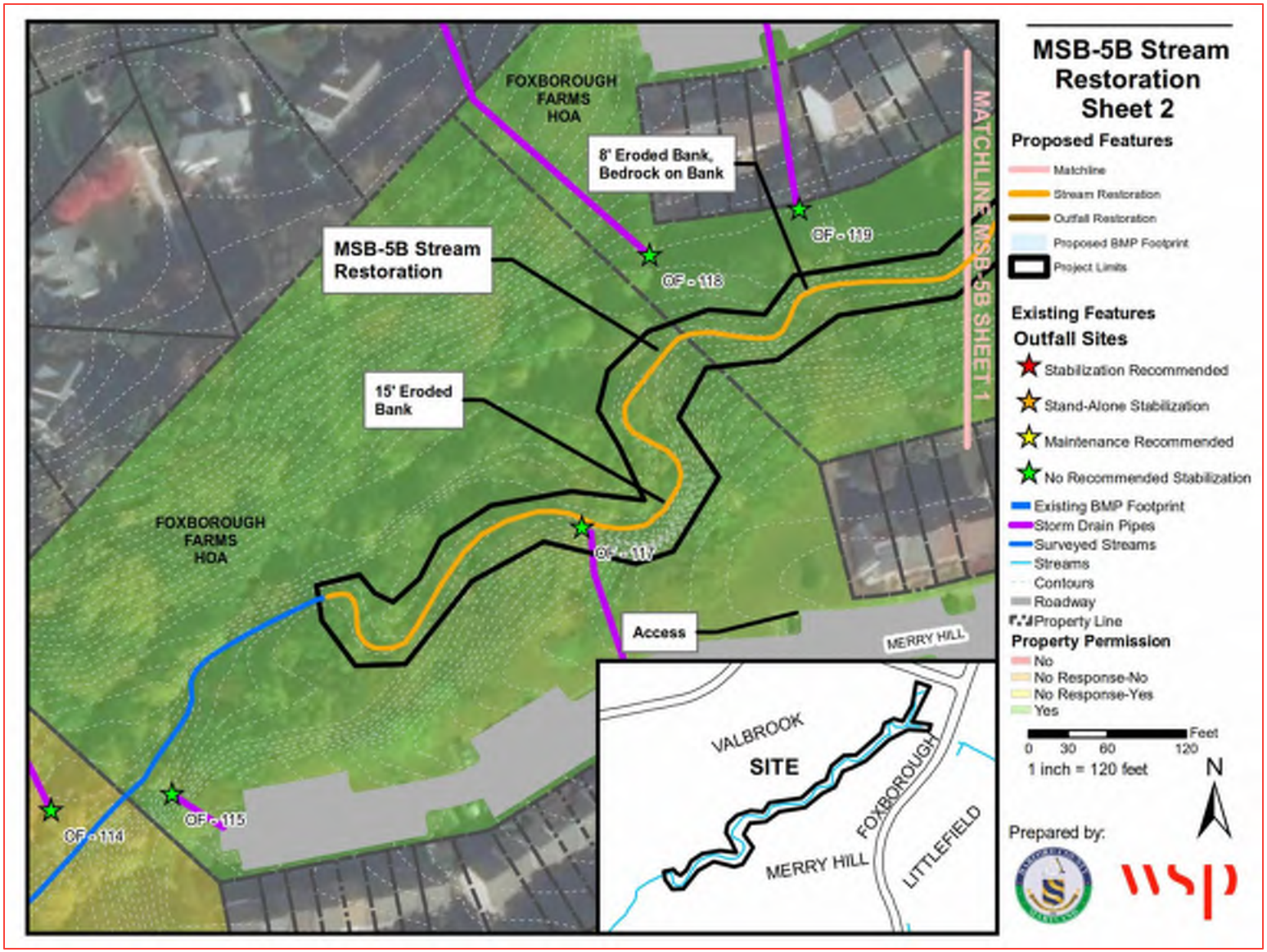

Figure C-65: Site Location and Proposed Project Plan for MSB-5B Stream Restoration (Sheet 2 of 2)

MSB-5C STREAM AND OUTFALL RESTORATION

Project Description	Restore 3,235 feet of stream and stabilize 137 feet of outfall channel • Outfall 98: Stabilize 97 feet • Outfall 99: Stabilize 40 feet
Location	South of Starmount Lane
Property Ownership	Nineteen Private Properties
Length of Project	3,235 feet of stream restoration and 137 feet of outfall stabilization
Potential Impervious Acres Treated	98.46 Acres
Potential Load Reductions TP	220.06 lbs/yr
Potential Load Reductions TN	242.71 lbs/yr
Potential Load Reductions TSS	145,304 lbs/yr
Estimated Design/Construction Costs	$2,055,150 $20,365/impervious acres treated
Adjacent Projects	BMP-P-4

Site Description

MSB-5C is comprised of two segments of stream totaling 3,235 feet and two outfall stabilizations. MSB-5C, Segment 1, contains a headwater stream and proposes two outfall stabilizations, outfalls 98 and 99, and 1,485 feet of stream restoration. The first 460 feet of the main stem have an average exposed height of 5 feet on both stream banks (Figure C-66, left). Throughout this section there are multiple, dry, stormwater runoff channels entering the stream from outfall structures, such as outfalls 98 and 99 as well as overland flow from adjacent residential units. The remaining MSB-5C, Segment 1, stream length has average exposed stream banks of 2 to 3 feet (Figure C-66, right).

Figure C-66: Left and right bank erosion with an average exposed height of 5 feet (left); Section of average exposed banks of 3 feet on the left bank (right)

Outfalls 98 and 99 convey flow from the Maryland County Club (Figure C-67). Multiple pipe sections have broken off into the eroded outfall channel. The eroded banks in these outfall channels are approximately 6 to 8 feet high. Both outfalls convey flow the left stream bank. Outfall 99 enters the left bank 300 feet downstream of the start of the project. The outfall channel for Outfall 98 ties into the stream on the left bank an additional 160 feet downstream of the Outfall 99 channel.

Figure C-67: Looking upstream toward Outfall 98 (left); Looking upstream toward Outfall 99 (right).

MSB-5C, Segment 2, is located southeast of Starmount Lane and includes 1,751 feet of proposed stream restoration. MSB-5C begins at Outfall 100 and conveys flow from Segment 1 as perennial flow. The outfall structure is in good condition, but the gabion baskets that protect the channel banks on either side of the outfall's wings and the channel bottom immediately downstream are impacted by erosion (Figure C-68, left). The gabion baskets create two steps, approximately two feet in height, ten feet and twenty-five feet linearly from the outfall's concrete apron to the main stream channel, respectively (Figure C-68, right).

Figure C-68: Downstream view of outfall 100 with erosion behind the left bank gabion baskets (left); Outfall 100 gabion basket channel protection (right).

The first 420 feet of stream below Outfall 100 contains 3 feet of exposed banks on either bank (Figure C-69, left). The next 300 feet, a more sinuous section, contains average exposed bank heights of 4 feet. The final 430 feet upstream of the tributary confluence has an of average 5 feet exposed bank. A silt fence currently runs along the right bank (Figure C-69, right).

Figure C-69: Downstream view of left bank erosion (left); Silt fence adjacent to stream channel (right).

A golf cart bridge crosses the stream approximately 550 feet upstream of the end of the project area. Twin 30-inch concrete pipes convey flow under the golf cart crossing. Upstream of the golf cart bridge crossing, stream banks average 4 feet of exposed banks and lack a riparian buffer on both banks (Figure C-70, left). Additionally, there are two exposed pipes along the stream bed within this stream channel section. Golf course personal identified these pipes as an irrigation pipe and its associated electric connection during the field assessment of the area.

Downstream of the golf cart crossing, stream banks average 5 feet of exposed bank (Figure C-70, right). A smooth metal pipe is exposed across the bottom of the stream approximately 70 feet from the

downstream limit of MSB-5C. Although the use of the pipe is unknown and there are no current signs of the pipe leaking, the presence of multiple, large, upstream, pieces of debris leave this pipe vulnerable to future impacts.

Figure C-70: Downstream view towards the channel golf cart crossing with inadequate buffer and erosion (left); five-foot exposed bank height downstream of golf cart crossing (right).

Recommended Restoration Actions

- **Stream Restoration**
    - *MSB-5C, Main Stem 1*: 1,485 feet from 296 feet upstream of Outfall 99 to 364 feet upstream of Starmount Lane outlet.
    - *MSB-5C, Main Stem 2*: 1,751 feet from the channel of Outfall 100 to the outlet at East Macphail Road.
- **Outfall Stabilization**
    - *Outfall 98*: Pipe replacement and 97 feet of stabilization
    - *Outfall 99*: Pipe replacement and 40 feet of stabilization
- Proposed project plans are shown in Figure C-71, Figure C-72, Figure C-73, Figure C-74, and Figure C-75.

Threats to Infrastructure

- Stream channel is within 20 feet of the buildings on and adjacent to 958 Whispering Ridge Lane.
- There are two exposed pipe locations (irrigation and electrical conduit) within the length of the stream restoration. The first is located above the stream channel and is susceptible to debris impacts during a large storm event. The second is exposed along the stream channel and will become vulnerable to debris impacts should erosion continue to occur around the pipe.

Property Ownership

There are numerous private property owners along this reach. Coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process.

Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, The Village of Scots Fancy Homeowners Association Inc.
- Private: 954 Whispering Ridge Lane
- Private: 956 Whispering Ridge Lane
- Private: 958 Whispering Ridge Lane
- Private: The Maryland Country Club Inc.
- Private: HOA, Woodland Greens Homeowners' Association Inc.
- Private: 1233 Kirby Circle
- Private: 1235 Kirby Circle
- Private: 1237 Kirby Circle
- Private: 1239 Kirby Circle
- Private: 1241 Kirby Circle
- Private: 1243 Kirby Circle
- Private: The Maryland Country Club Inc.
- Private: HOA, The Village of Scots Fancy Homeowners Association Inc.
- Private: 906 Whispering Ridge Lane
- Private: 904 Whispering Ridge Lane
- Private: 907 Candlelight Court
- Private: 905 Candlelight Court
- Private: 903 Candlelight Court

Access

- Moderate Access at the headwaters of the project area from the Maryland Country Club Parking lot for stream restoration and Outfalls 98 and 99 stabilization.
- Good Access at East Macphail Road at the golf cart entrance, St. Andrew's Way, for stream restoration.
- Moderate Access at the Open Space along Starmount Lane for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-28. Two outfall stabilization projects, totaling 137 linear feet are recommended alongside 3,236 linear feet of stream restoration. The construction of 3,236 linear feet of stream restoration and 137 feet of outfall stabilization in this project will treat 98.46 impervious acres within the watershed. This treatment amount accounts for approximately 7.4% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $2,055,150 for the MSB-5C Stream and Outfall Restoration project. This cost estimate includes one medium outfall stabilization project, one large outfall stabilization project and a large stream restoration project. Cost estimates for each project type

are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-29.

Table C-28: Summary of Improvements for MSB-5C Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-98	1.38	0.8	97	0.97	-	-	-
	OF-99	1.42	0.57	40	0.40	-	-	-
Stream	MSB-5C	228.26	50.09	3,236	97.09	242.71	220.06	145,304
Total Credit/ Reductions				**3,373**	**98.46**	**242.71**	**220.06**	**145,304**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-29: Summary of Project Costs for MSB-5C Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-98	Medium	$50,000	Project	$50,000	
	OF-99	Large	$100,000	Project	$100,000	
Stream	MSB-5C	Large	$550	L.F.	$1,855,150	$19,108
Total Costs					**$2,005,150**	**$20,365**

*Project cost divided by stream restoration impervious area treated

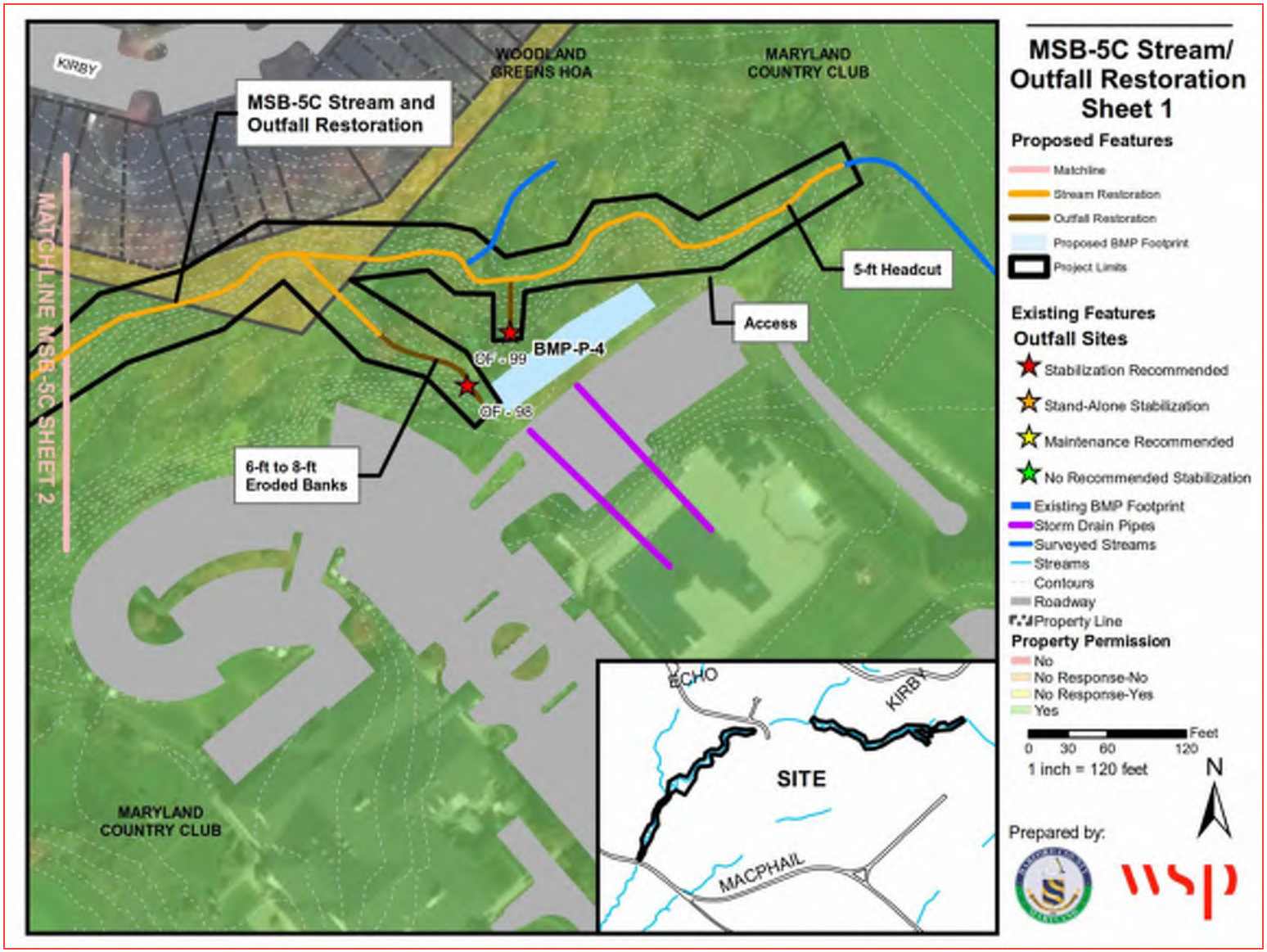

Figure C-71: Site Location and Proposed Project Plan for MSB-5C Stream and Outfall Restoration (Sheet 1 of 5)

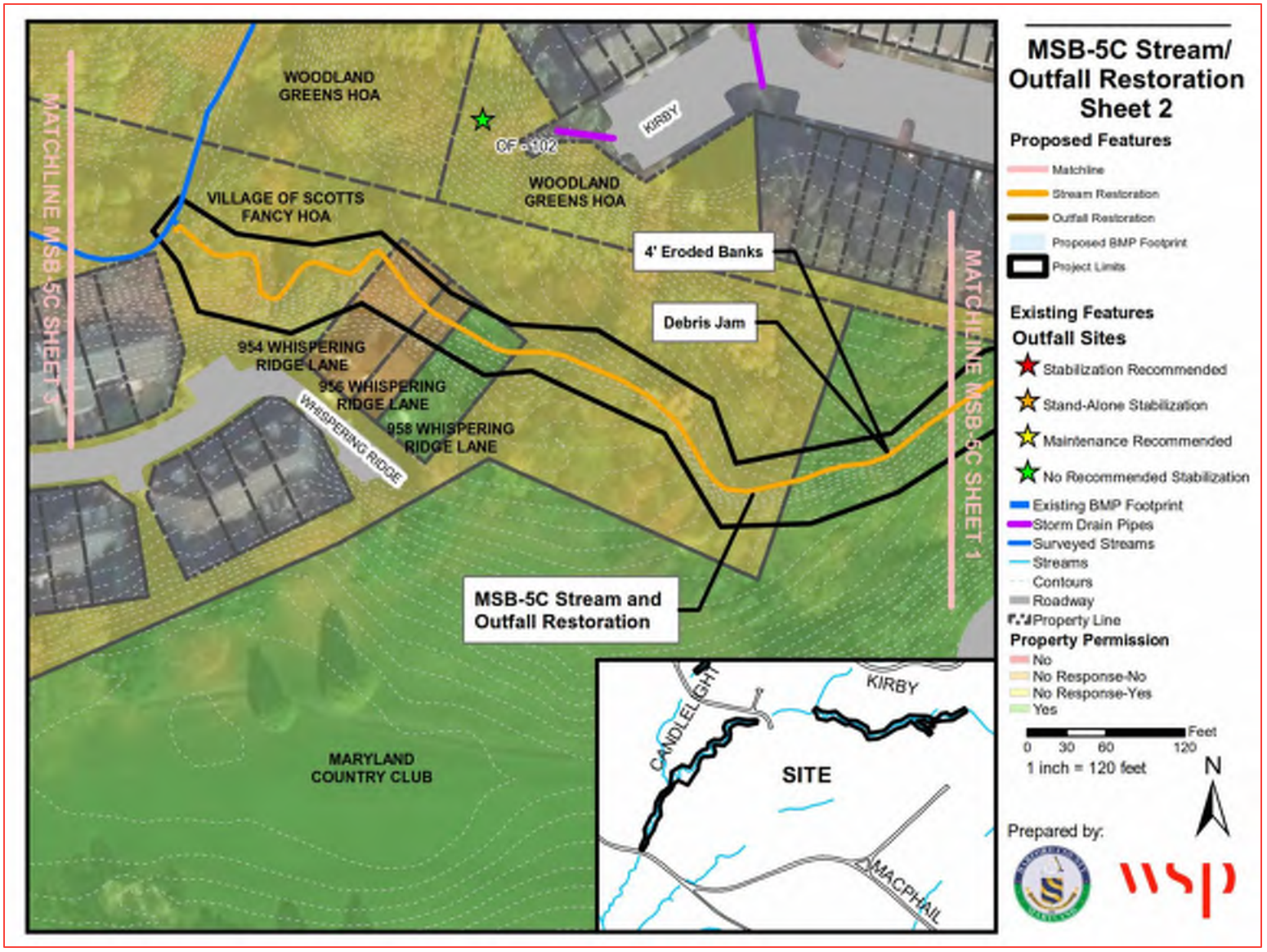

Figure C-72: Site Location and Proposed Project Plan for GrMSB-5C Stream and Outfall Restoration (Sheet 2 of 5)

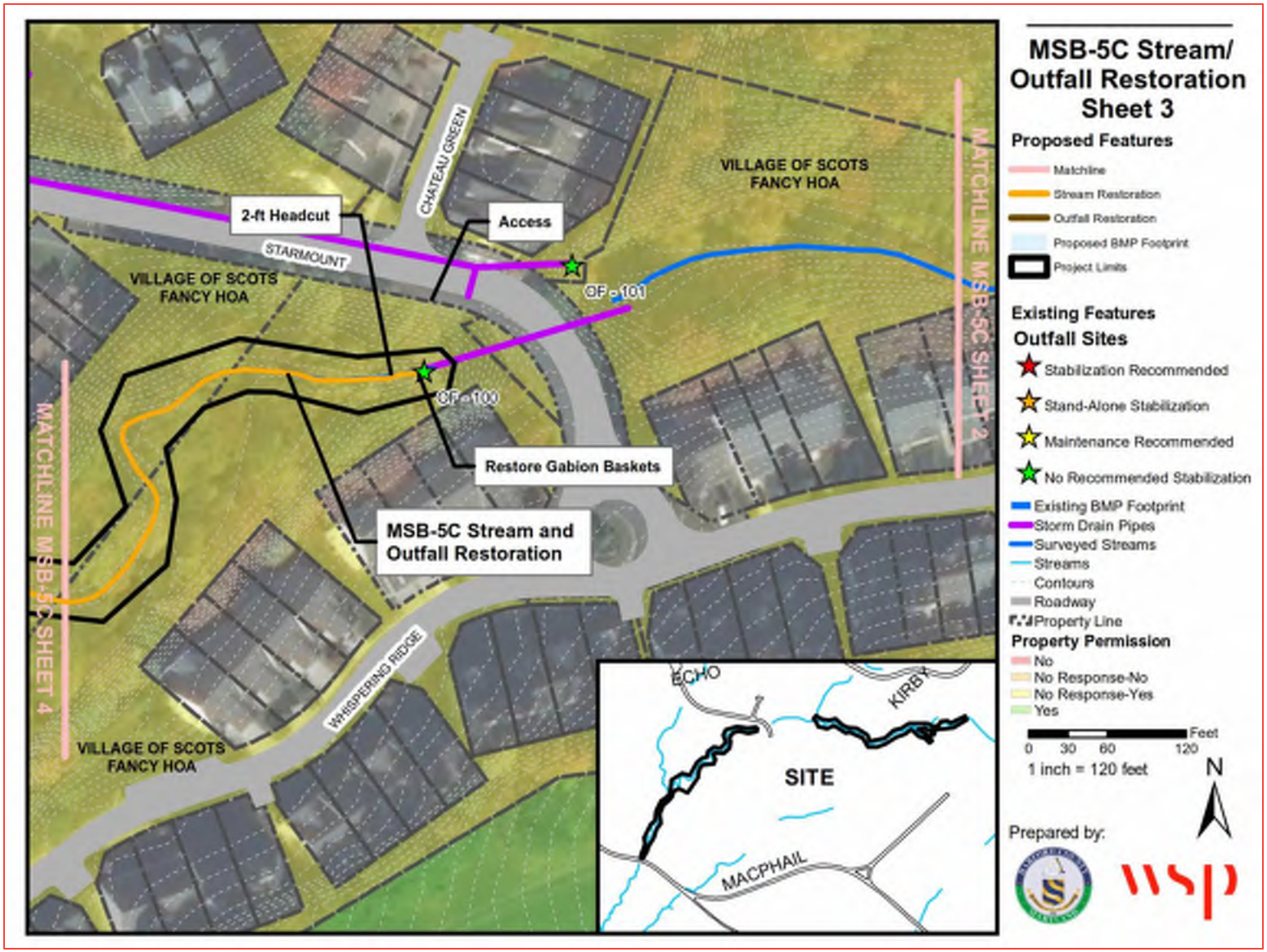

Figure C-73: Site Location and Proposed Project Plan for MSB-5C Stream and Outfall Restoration (Sheet 3 of 5)

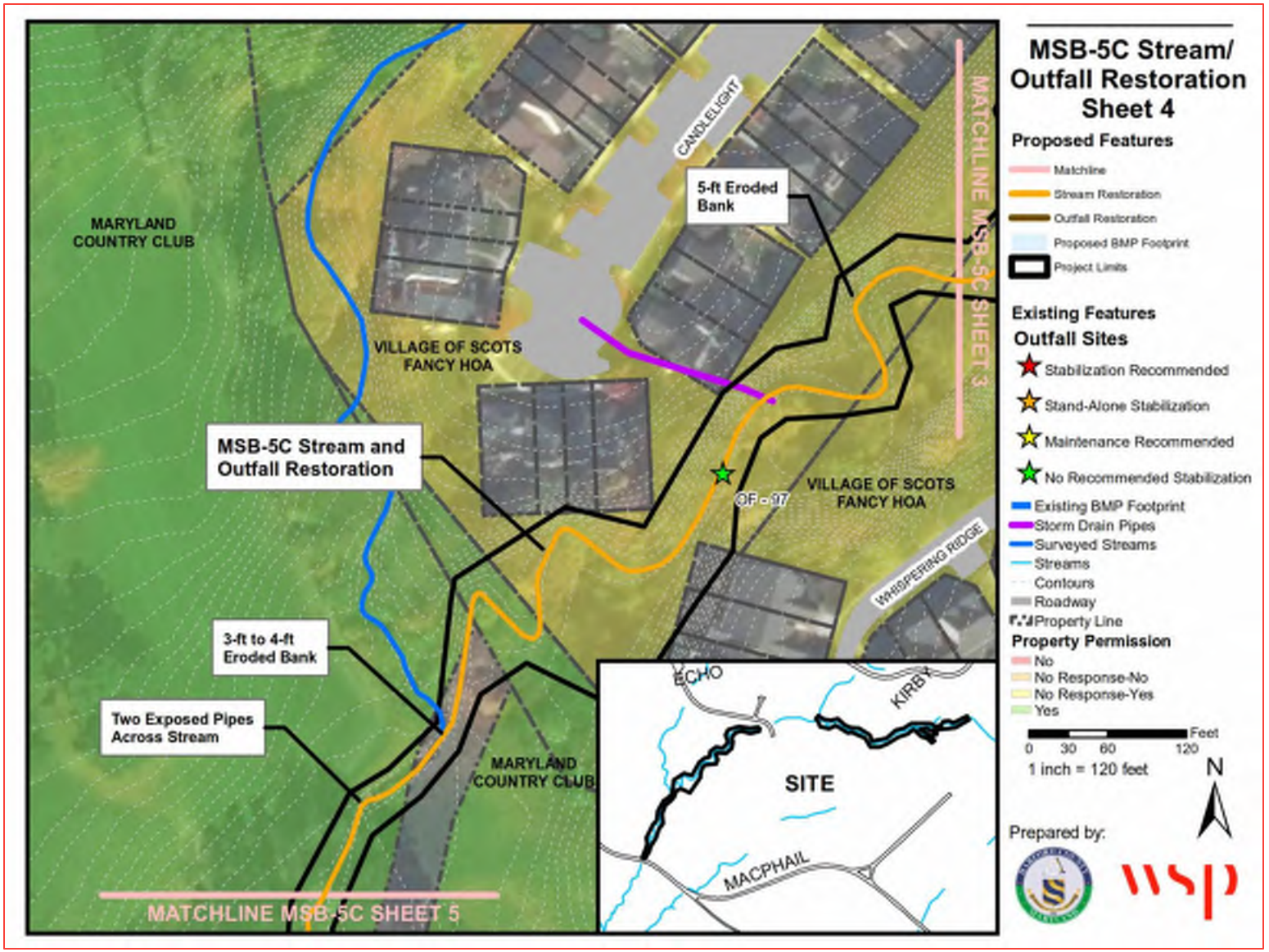

Figure C-74: Site Location and Proposed Project Plan for MSB-5C Stream and Outfall Restoration (Sheet 4 of 5)

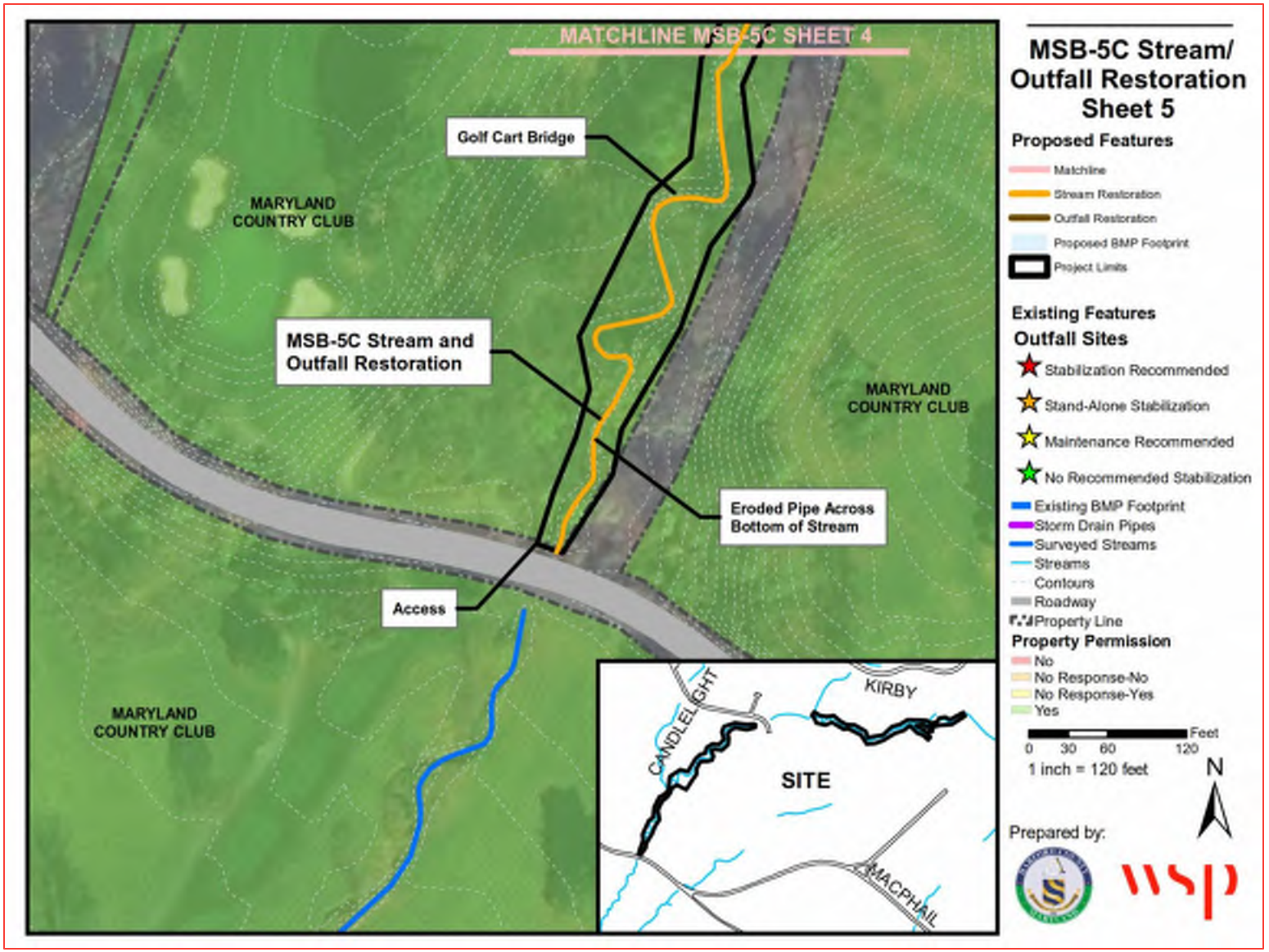

Figure C-75: Site Location and Proposed Project Plan for MSB-5C Stream and Outfall Restoration (Sheet 5 of 5)

MSB-5D STREAM AND OUTFALL RESTORATION

Project Description	Restore 3,354 linear feet of stream and stabilize 216 feet of outfall channel • Outfall 82: Stabilize 47 feet • Outfall 85: Stabilize 79 feet • Outfall 175: Stabilize 90 feet
Location	Kings Charter HOA: near David Drive
Property Ownership	One Private Property and One Public Property
Length of Project	3,354 feet of stream restoration and 216 feet of outfall restoration
Potential Impervious Acres Treated	102.76 Acres
Potential Load Reductions TP	228.10 lbs/yr
Potential Load Reductions TN	251.58 lbs/yr
Potential Load Reductions TSS	150,615 lbs/yr
Estimated Design/Construction Costs	$1,969,700 $19,168/impervious acres treated
Adjacent Projects	None

Site Description

Project MSB-5D is bordered by Inglewood Road to the northeast, David Drive to the south, and Patterson Mill Junior High School to the west. It proposes 3,354 feet of stream restoration on two converging headwater streams as well as three outfall stabilization projects, outfalls 82, 85, and 175. From the upstream limit of the mainstem of Project MSB-5D, stream banks experience an average of 3 feet for 800 feet (Figure C-76, left). An inadequate buffer develops on the right bank for approximately 200 feet, within the first 800 feet of the project. For the next 480 feet, the exposed stream banks increase to 5 feet. Eroded banks increase in height from 5 feet to 7 feet for the next 1000 feet of stream channel (Figure C-76, right).


Figure C-76: Left bank moderate severity with an average of 3 feet exposed banks (left); Severe Severity Erosion on the right and left banks at 7 feet exposed bank heights (right)

The channel slope decreases for the last 800 feet of stream, the stream channel widens, and the bank heights decrease to 3 feet. The tributary has average exposed banks of 4 feet (Figure C-77, left).


Figure C-77: Moderate eroded banks with an average exposed bank height of 4 feet in the second tributary (left); Erosion downstream of Outfall 79 at the confluence with the main stem (right)

Although the structures of all six of the proposed outfall stabilization projects are in good condition, there is evidence of active erosion occurring in and damage to the outfall channels connecting the outfalls to the streams, despite the presence of outfall protection at each of the sites. Outfall 175 is approximately 1800 feet downstream of the beginning of MSB-5D, main stem. The outfall is a 30-inch RCP pipe with a concrete endwall. A sediment basin, to the left of the outfall, receives a portion of the flow leaving the outfall; however, the majority of the runoff flows over gabion basket outfall protection to a severely incised outfall channel. At the end of the gabion basket, a headcut lowers the outfall channel by 3.5 feet. There is 2-foot headcut an additional 40 feet downstream. A 4-foot headcut was observed where the outfall channel ties into the stream channel (Figure C-78, right).

Outfall 82 is located 170 feet downstream of Outfall 175. Outfall 82 is an 18-inch RCP pipe with a concrete endwall. The outfall channel is lined with riprap; however, the riprap has shifted in some places, exposing the underlying geotextile material. A sediment basin is located adjacent to the outfall structure and receives a portion of the flow from the outfall. The majority of the runoff flows down the outfall channel, causing erosion and displacement of riprap. A 5-foot headcut was observed at where the outfall channel ties into the stream channel (Figure C-78, right).

Figure C-78: 3 feet exposed banks downstream of basin outlet protection for Outfall 175 (left); Outfall 82 riprap channel protection extending to the stream channel with adjacent erosion (right)

Outfall 85 is located along the tributary, approximately 165 feet downstream of the start of the project. The outfall is a 30-inch RCP pipe with a concrete endwall. A sediment basin is located at the outfall and is in poor condition. The outfall basin is surrounded by a wooden fence, is overgrown with trees and shrubs, and is filled with sediment. Approximately 65 feet downstream of the outfall, the outfall channel experiences a 2-foot headcut along with steep slopes. Riprap in this section of the outfall channel has been pushed downstream, revealing the underlying geotextile material (Figure C-79). Another 3.5-foot headcut was observed where the outfall channel ties in with the stream.

Figure C-79: Exposed geotextile and missing riprap along steep section of Outfall 85 channel

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-5D, Main Stem*: 2,849 feet from Outfall 173 to SWM000363.
  - *MSB-5D, Tributary*: 505 feet from Outfall 176 to SWM000363.
- **Outfall Stabilization**
  - *Outfall 82*: Remove sediment and small trees from water quality basin and stabilize 47 feet of outfall channel from edge of water quality basin to the stream channel
  - *Outfall 85*: Remove sediment and trees from water quality basin and stabilize 79 feet of outfall channel from the edge of the water quality basin to the stream channel
  - *Outfall 175*: Remove sediment and trees from water quality basin and stabilize 90 feet of outfall channel from the edge of the water quality basin to the stream channel.
- Proposed project plans are shown in Figure C-80, Figure C-81, Figure C-82, and Figure C-83.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There is one private property owner and one public property owner along this reach. Coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. It is recommended that the County try to obtain buy in after conceptual design level.

- Public: Board of Education of Harford County
- Private: HOA, Kings Charter Homeowners Association Inc.

Access

- Good Access at Patterson Mill Junior High School for stream restoration and Outfall 79 maintenance.

- Good Access at 1817 Bayonne Court along stormwater easement for stream restoration and Outfall 82 and Outfall 175 stabilization.
- Good Access behind 535 Inglewood Drive at stormwater easement for stream restoration and Outfall 85 stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-30. Three outfall stabilization projects, totaling 216 linear feet are recommended alongside 3,354 linear feet of stream restoration. The construction of 3,354 linear feet of stream restoration and 216 feet of outfall stabilization in this project will treat 102.76 impervious acres within the watershed. This treatment amount accounts for approximately 7.8% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,969,700 for the MSB-5D Stream and Outfall Restoration project. This cost estimate includes one small outfall stabilization project, two medium outfall stabilization projects, and a large stream restoration project. Cost estimates for each project type are described at the beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-31.

Table C-30: Summary of Improvements for MSB-5D Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-82	1.2	0.6	47	0.47	-	-	-
	OF-85	4.2	1.5	79	0.79	-	-	-
	OF-175	6.8	3.0	90	0.90	-	-	-
Stream	MSB-5D	95.32	15.23	3,354	100.6	251.58	228.10	150,615
Total Credit/ Reductions				**3,670.6**	**102.76**	**251.58**	**228.10**	**150,615**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions equal restoration length times 44.9 lbs/ft/yr

Table C-31: Summary of Project Costs for MSB-5D Stream and Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-82	Small	$25,000	Project	$25,000	
	OF-85	Medium	$50,000	Project	$50,000	
	OF-175	Medium	$50,000	Project	$50,000	
Stream	MSB-5D	Large	$550	L.F.	$1,844,700	$18,337
Total Costs					**$1,969,700**	**$19,168**

*Project cost divided by stream restoration impervious area treated

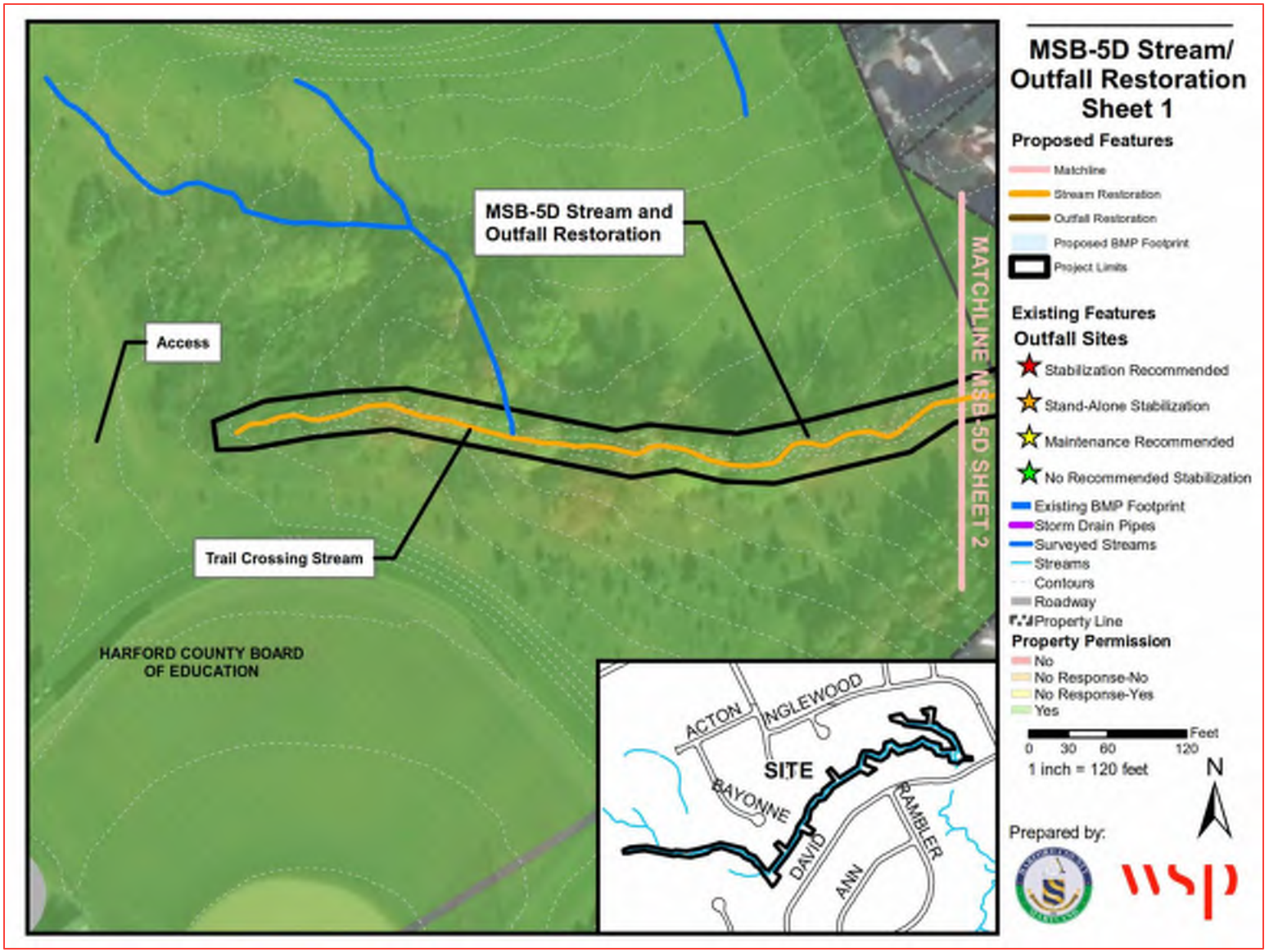

Figure C-80: Site Location and Proposed Project Plan for MSB-5D Stream and Outfall Restoration (Sheet 1 of 4)

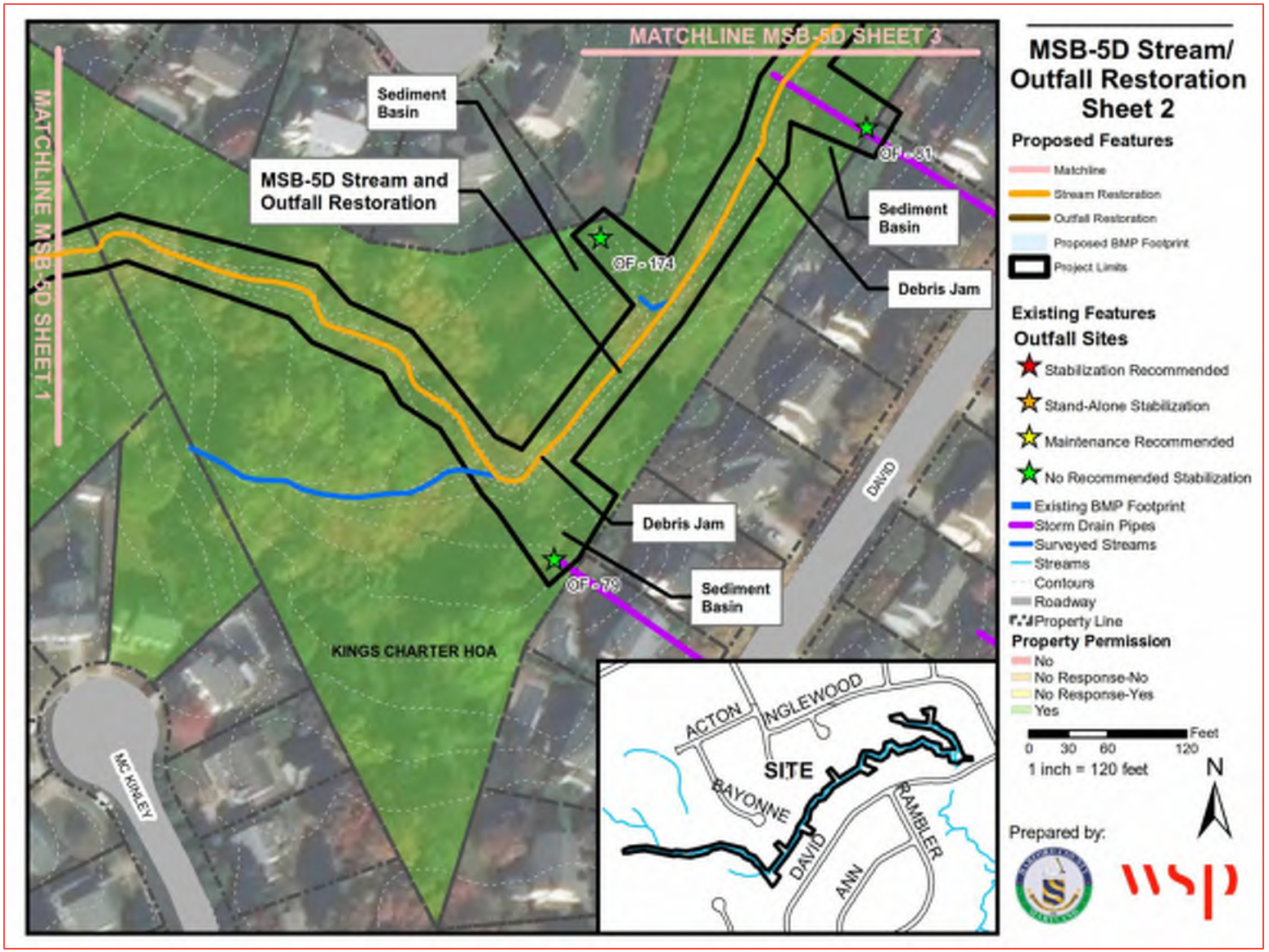

Figure C-81: Site Location and Proposed Project Plan for MSB-5D Stream and Outfall Restoration (Sheet 2 of 4)

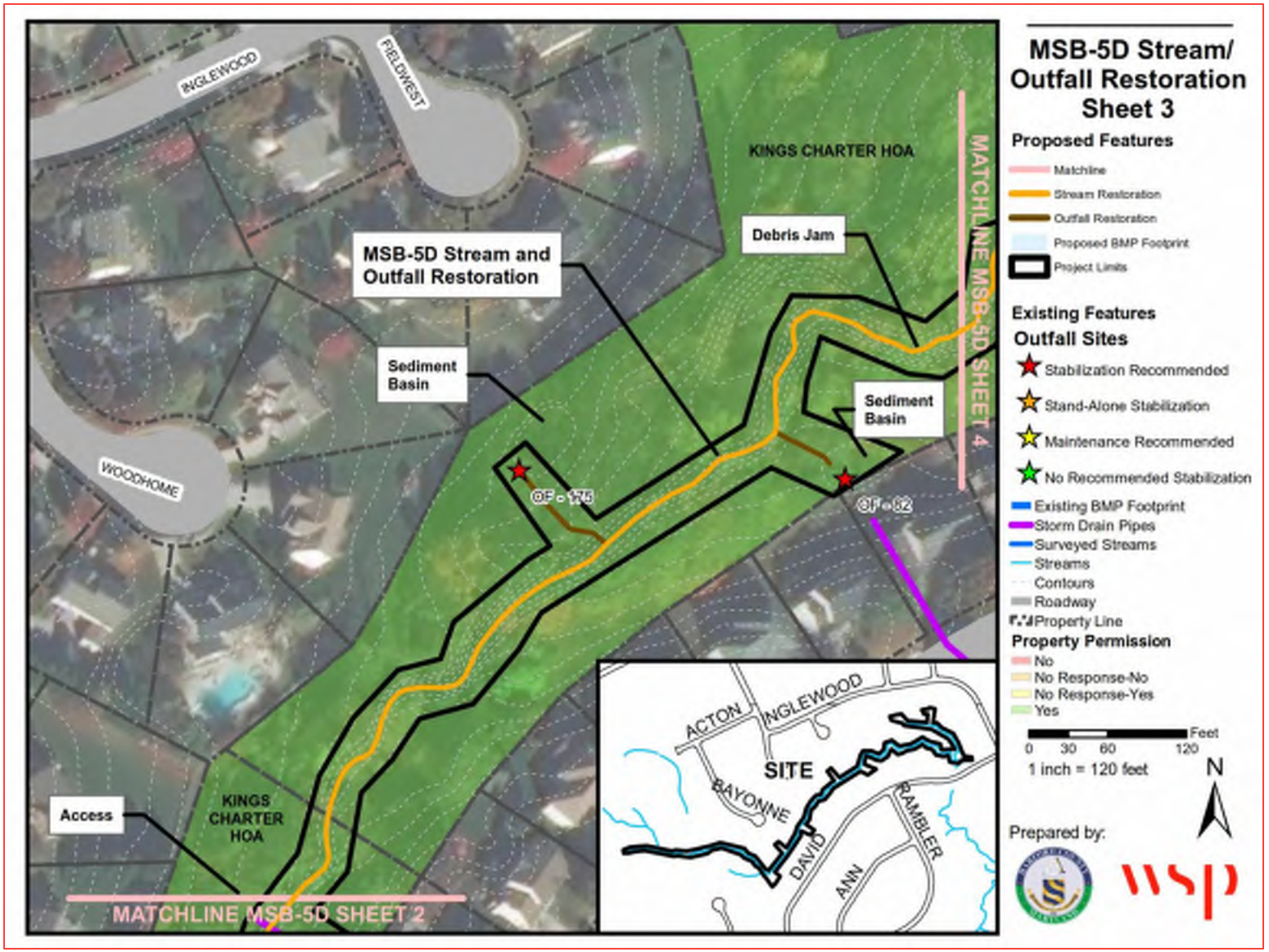

Figure C-82: Site Location and Proposed Project Plan for MSB-5D Stream and Outfall Restoration (Sheet 3 of 4)

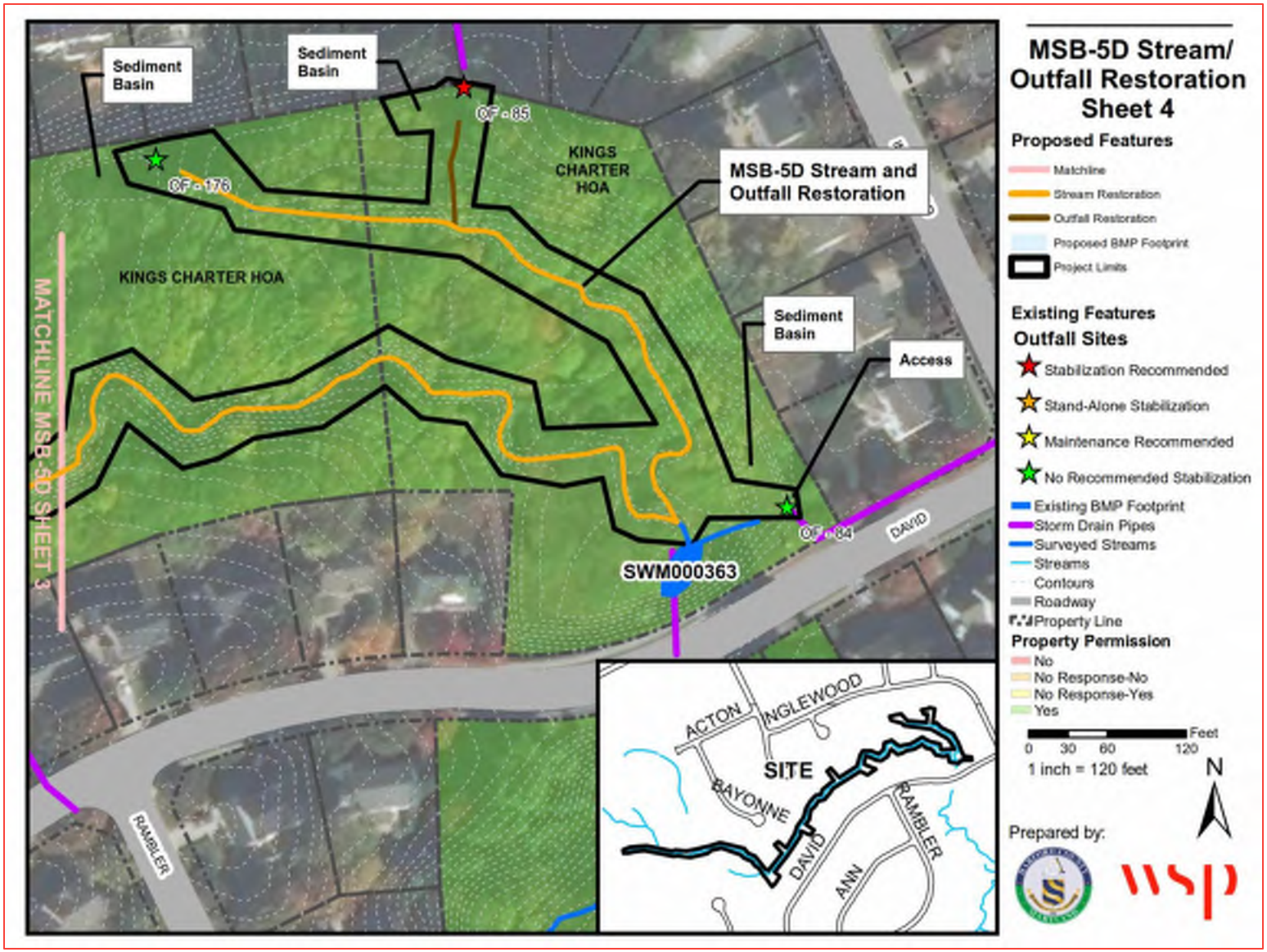

Figure C-83: Site Location and Proposed Project Plan for MSB-5D Stream and Outfall Restoration (Sheet 4 of 4)

MSB-5E STREAM RESTORATION

Project Description	Restore 743 feet of stream.
Location	South of Inglewood Road and North of David Drive
Property Ownership	One Private Property
Length of Project	743 feet of stream restoration
Potential Impervious Acres Treated	22.28 Acres
Potential Load Reductions TP	50.49 lbs/yr
Potential Load Reductions TN	55.69 lbs/yr
Potential Load Reductions TSS	33,339 lbs/yr
Estimated Design/Construction Costs	$556,980 $24,995/impervious acres treated
Adjacent Projects	None

Site Description

Project MSB-5E is located east of Patterson Mill Road and contains 743 feet of stream restoration. From the upstream limit, approximately 225 feet of stream has an average exposed height of 3 feet (Figure C-84, left). There is an exposed pipe crossing above the stream bed within this section which is vulnerable to debris impacts during storm events. An additional 165 feet of stream banks are eroded 6 feet high (Figure C-84, right).

Figure C-84: 3-foot vertical exposed heights on the left and right banks and exposed pipe. (left); Right bank erosion with a height of 6 foot banks (right)

Approximately 260 feet downstream of the start of the project, the stream bank curves around a private property pond and private residence. The left stream bank has been stabilized with riprap and is in good condition. The stream near the pond and residence is unshaded due to mowing up to the stream bank (Figure C-85, left). A bridge for the private residence crosses the stream 110 feet upstream of the end of the project area. Erosion and sediment deposition is occurring upstream of the bridge crossing. The

remaining 110 feet of stream have exposed banks 4 feet high at the edge of a horse pasture. The stream has eroded and shifting, requiring the posts to be placed in the stream channel (Figure C-85, right).

Figure C-85: Residential pipe outfalls and inadequate buffer at the back of residential property (Left); Moderate severity bank erosion with an average of 4 feet exposed bank height on both banks (right).

Recommended Restoration Actions

- **Stream Restoration**
    - *MSB-5E, Main Stem*: 743 feet from southwestern corner of 445 Patterson Mill Road to 131 feet upstream of the property line of 445 Patterson Mill Road.
- Proposed project plans are shown in Figure C-86.

Threats to Infrastructure

- An exposed pipe with an unknown use is threatened due to its height above the stream channel bottom. This makes it more vulnerable to debris impacts.
- A private pond embankment has been reinforced with riprap where the stream runs along the pond embankment. Erosion may threaten the pond embankment.
- A private driveway bridge crosses the stream. Significant erosion has widened the channel upstream of the bridge and will impact the bridge in the future.

Property Ownership

There is one private property owner along this reach. Buy in from this property owner at the beginning of the project is necessary for the successful completion of the restoration design. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: 445 Patterson Mill Road

Access

- Good Access on 445 Patterson Mill Road for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-32. This project recommends 742.52 linear feet of stream restoration. The construction of 742.52 linear feet of stream restoration in this project will treat 22.28 impervious acres within the watershed. This treatment amount accounts for approximately 1.7% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $556,890 for the MSB-5E Stream Restoration project. This cost estimate includes one small stream restoration project. Cost estimates for each project type are described at beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-33.

Table C-32: Summary of Improvements for MSB-5E Stream Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-5E	147.23	24.82	742.52	22.28	55.69	50.49	33,339
Total Credit/ Reductions				**742.52**	**22.28**	**55.69**	**50.49**	**33,339**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-33: Summary of Project Costs for MSB-5E Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-5E	Small	$750	L.F.	$556,890	$24,995
Total Costs					**$556,890**	**$24,995**

*Project cost divided by stream restoration impervious area treated

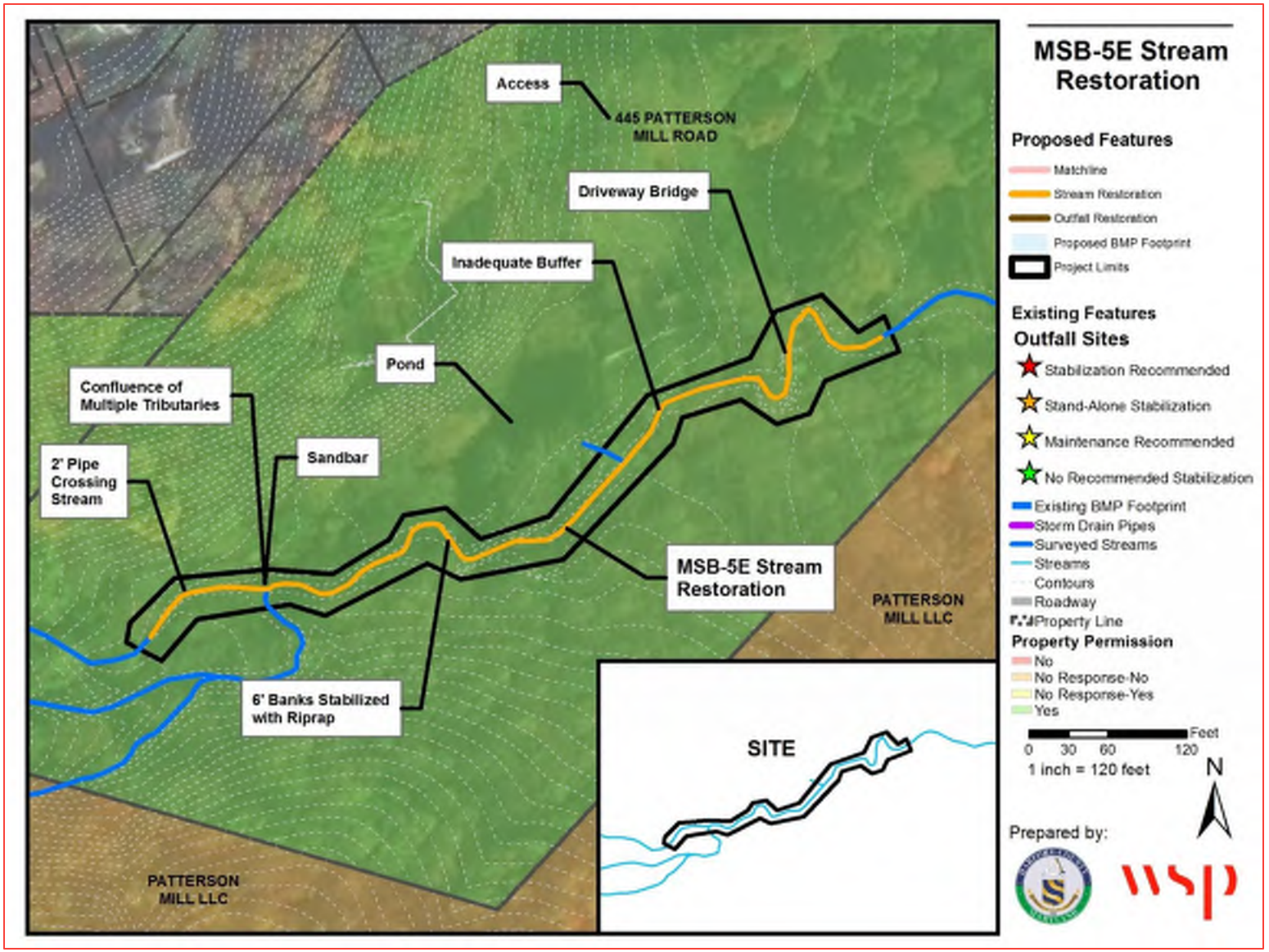

Figure C-86: Site Location and Proposed Project Plan for MSB-5E Stream Restoration (Sheet 1 of 1)

MSB-5F OUTFALL RESTORATION

Project Description	Stabilize 90 feet of channel at Outfall 80
Location	Between 435 Rambler Road and 437 Rambler Road
Property Ownership	Two private properties
Length of Project	90 feet of outfall stabilization
Potential Impervious Acres Treated	0.90 Acres
Potential Load Reductions TP	N/A
Potential Load Reductions TN	N/A
Potential Load Reductions TSS	N/A
Estimated Design/Construction Costs	$100,000 $111,111/impervious acres treated
Adjacent Projects	N/A

Site Description

The upstream limit of MSB-5F is located behind the private residences of 435 Rambler Road and 437 Rambler Road. It proposes a stand-alone stabilization of 90 feet of channel at outfall 80. The outfall consists of a 30-inch diameter RCP with a concrete end section. The manhole structure is cracked with exposed rebar and the end section is no longer connected to the RCP (Figure C-87, left). The outfall protection consists of a gabion mattress, with riprap displaced and a fence missing at the overflow location (Figure C-87, right).

Figure C-87: Outfall 80 (left); Gabion mattress at outfall (right)

At the outfall, there is a sediment basin covered in leaf litter (Figure C-88, left). There is severe erosion in the downstream channel for the 80 feet until the channel's confluence with the receiving stream (Figure C-88, right).

Figure C-88: Sediment basin (left); Severe erosion downstream of outfall 80 (right).

Recommended Restoration Actions

- **Outfall Stabilization**
    - *Outfalls 80:* Fill in sediment basin, replace drop structure with 6-foot deep drop structure, install plunge pool, grade outfall channel and line with riprap protection.
- Proposed project limits are shown in Figure C-89.

Threats to Infrastructure

- There are currently no threats to infrastructure within the project area.

Property Ownership

There are two private property owners along this reach and coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or both of the property owners drop out of the project late in the design will likely necessitate a redesign of the outfall and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Kings Charter Homeowners Association Inc.
- Private: 435 Rambler Road
- Private: 437 Rambler Road

Access

- Moderate Access between 435 Rambler Road and 437 Rambler Road for outfall stabilization.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-34. The construction of 90 linear feet of outfall stabilization in this project will treat 0.9 impervious acres within the watershed. This treatment amount accounts for approximately 0.07% of the impervious area within the watershed.

Project Costs

The total project cost (excluding ROW/easements) is $100,000 for the MSB-5F Outfall Restoration project. This cost estimate includes one large outfall stabilization project. The cost estimate for the project type is described at the beginning of Appendix C. The cost estimate for this project is provided in Table C-35.

Table C-34: Summary of Improvements for MSB-5F Outfall Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall	OF-80	14.1	4.76	90	0.90	-	-	-
Stream								
Total Credit/ Reductions				**90**	**0.90**			

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-35: Summary of Project Costs for MSB-5F Outfall Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNIT	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall	OF-80	Large	$100,000	Project	$100,000	
Stream						
Total Costs					**$100,000**	**$111,111**

*Project cost divided by stream restoration impervious area treated

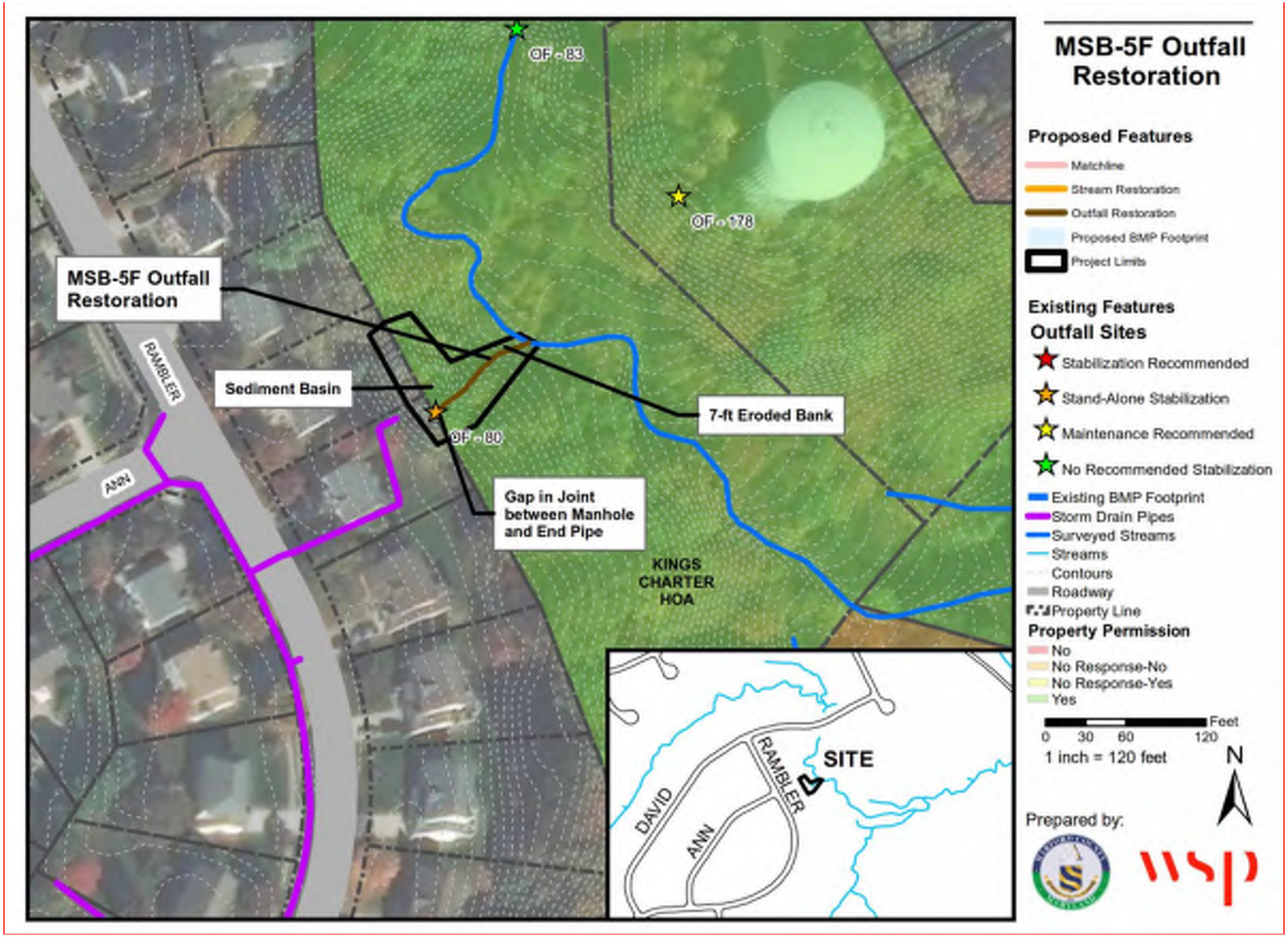

Figure C-89: Site Location and Proposed Project Plan for MSB-5F Outfall Restoration

MSB-6A STREAM RESTORATION

Project Description	Restore 2,649 feet of stream
Location	South of Fountain Glen Drive, West of Fountain Glen Drive
Property Ownership	Six Private Properties
Length of Project	2,649 feet of stream restoration
Potential Impervious Acres Treated	79.46 Acres
Potential Load Reductions TP	180.10 lbs/yr
Potential Load Reductions TN	198.64 lbs/yr
Potential Load Reductions TSS	118,919 lbs/yr
Estimated Design/Construction Costs	$1,781,850 $21,669/impervious acres treated
Adjacent Projects	None

Site Description

Project MSB-6A is comprised of two segments of stream, totaling 2,649 feet. The first segment is located southeast of Fountain Glen Drive and contains 1,752 feet of proposed stream restoration and five outfalls. Four of the outfalls (141, 143, 144, and 145) have eroded at the end of the outfall protection (Figure C-90 & Figure C-91).

Figure C-90: Eroded end of outfall protection for Outfall 141 (left); Outfall 143 (right).

Figure C-91: Eroded end of outfall protection for Outfall 144 (left): Outfall 145 (right).

Along the right bank, the entire length of MSB-6A has bank heights of 7 feet (Figure C-92, left). The first 606 feet of the left side have average exposed bank heights of 2 feet while the remaining stream reach has banks averaging 5 feet high (Figure C-92, right).

Figure C-92: Severe erosion along the right bank (left); Low severity along the left bank (right)

The second segment is located west of Fountain Glen Drive and south of Streamview Court. It contains 897 feet of proposed stream restoration and two outfalls. One outfall, OF 184, is an outfall from a SWM facility and is in good condition but due to its proximity to the stream could be included in the stream restoration (Figure C-93, left). Approximately 150 feet upstream of MSD-6A, there are two outfalls conveying flow from a neighborhood and the stream. The outfall channel is protected with gabion baskets and does not need stabilization. The first 178 feet of the left side and 66 feet of the right side of MSB-6A, Segment 2, have average exposed bank heights of 3 feet (Figure C-93, right).

Figure C-93: Outfall 184 from SWM facility (left); Left bank low severity erosion (right)

Continuing downstream, there are 241 feet on the left bank and 481 feet on the right bank of severe erosion containing 8 feet and 9 feet average exposed bank heights, respectively (Figure C-94, left). The last 353 feet of the left bank and last 214 feet of the right bank have minor erosion and average exposed bank heights of 3ft (Figure C-94, right).

Figure C-94: Left bank severe erosion (left); Right bank minor erosion (right).

Recommended Restoration Actions

- **Stream Restoration**
  - *MSB-6A, Segment 1*: 1,752 feet from Outfall 181 to 496 feet upstream of SWM000163.
  - *MSB-6A, Segment 2*: 897 feet from Outfall 134 and Outfall 132 to 1138 Starmount Court.
- Proposed project plans are shown in Figure C-95, Figure C-96, Figure C-97, and Figure C-98.

Threats to Infrastructure

- Due to the proximity of a sanitary sewer line along the profile of the steam, any meandering from the stream profile could expose the line and risk the line's stability.

Property Ownership

There are numerous private property owners along this reach. Coordinating buy in from the property owners at the beginning of the project will help limit major changes to the project later in design process. Having one or two critical property owners drop out of the project late in the design will likely necessitate a redesign of the stream channel and project delays. It is recommended that the County try to obtain buy in after conceptual design level.

- Private: HOA, Fountain Glen Homeowners Association Inc.
- Private: 606 Carloway Place
- Private: 1138 Starmount Court
- Private: 1140 Starmount Court
- Private: HOA, Emerald Hills Community Association Inc.
- Private: HOA, Fountain Glen Homeowners Association Inc.

Access

- Good Access at the stormwater easement parallel to 610 Lochern Terrace for stream restoration and Outfall 143 and Outfall 144 stabilization.
- Good Access at the sanitary sewer easement parallel to 631 Kildonan Court for stream restoration.
- Good Access at the Open Space adjacent to 642 Gairloch Place for stream restoration.
- Good Access at the stormwater easement between 1139 and 1140 Starmount Court for stream restoration.
- Good Access at the Open Space north of 1406 Fountain Glen Drive for stream restoration.

Summary of Restoration Improvements

A summary of improvements for this project are provided in Table C-36. Stream restoration along 2,649 linear feet of stream is recommended for this project. The construction of 2,649 linear feet of stream restoration will treat 79.46 impervious acres within the watershed. This treatment amount accounts for approximately 6.0% of the impervious area within the watershed.

Project Costs

Total project costs (excluding ROW/easements) are $1,781,850 for the MSB-6A Stream Restoration project. This cost estimate includes a medium stream restoration project. Cost estimates for each project type are described at beginning of Appendix C. The cost estimate for each component of the project as well as the total project cost are provided in Table C-37.

Table C-36: Summary of Improvements for MSB-6A Stream Restoration

PROJECT TYPE	PROJECT NAME	DRAINAGE AREA (ACRES)	IMPERVIOUS AREA (ACRES)	RESTORATION LENGTH (FEET)	IMPERVIOUS AREA CREDIT (ACRES) †	TN REDUCTIONS (LBS/YEAR) *	TP REDUCTIONS (LBS/YEAR) **	TSS REDUCTIONS (LBS/YEAR) ***
BMP								
Outfall Maintenance								
Outfall								
Stream	MSB-6A	169.76	47.22	2,649	79.46	198.64	180.10	118,919
Total Credit/ Reductions				**2,649**	**79.46**	**198.64**	**180.10**	**118,919**

†Impervious Area Credit for outfall stabilization equals restoration length times 0.01
†Impervious Area Credit for stream restoration within the Coastal Plains equals restoration length times 0.02
†Impervious Area Credit for stream restoration outside of the Coastal Plains equals restoration length times 0.03
*TN reductions equal restoration length times 0.075 lbs/ft/yr
**TP reductions equal restoration length times 0.068 lbs/ft/yr
***TSS reductions for restoration within the Coastal Plains equals restoration length times 15 lbs/ft/yr
***TSS reductions for restoration outside of the Coastal Plains equals restoration length times 44.9 lbs/ft/yr

Table C-37: Summary of Project Costs for MSB-6A Stream Restoration

PROJECT TYPE	PROJECT NAME	PROJECT SIZE	UNIT COST	UNITS	PROJECT COST	COST/IMPERVIOUS ACRE TREATED*
BMP						
Outfall Maintenance						
Outfall						
Stream	MSB-6A	Medium	$650	L.F.	$1,721,850	$21,669
Total Costs					**$1,721,850**	**$21,669**

*Project cost divided by stream restoration impervious area treated

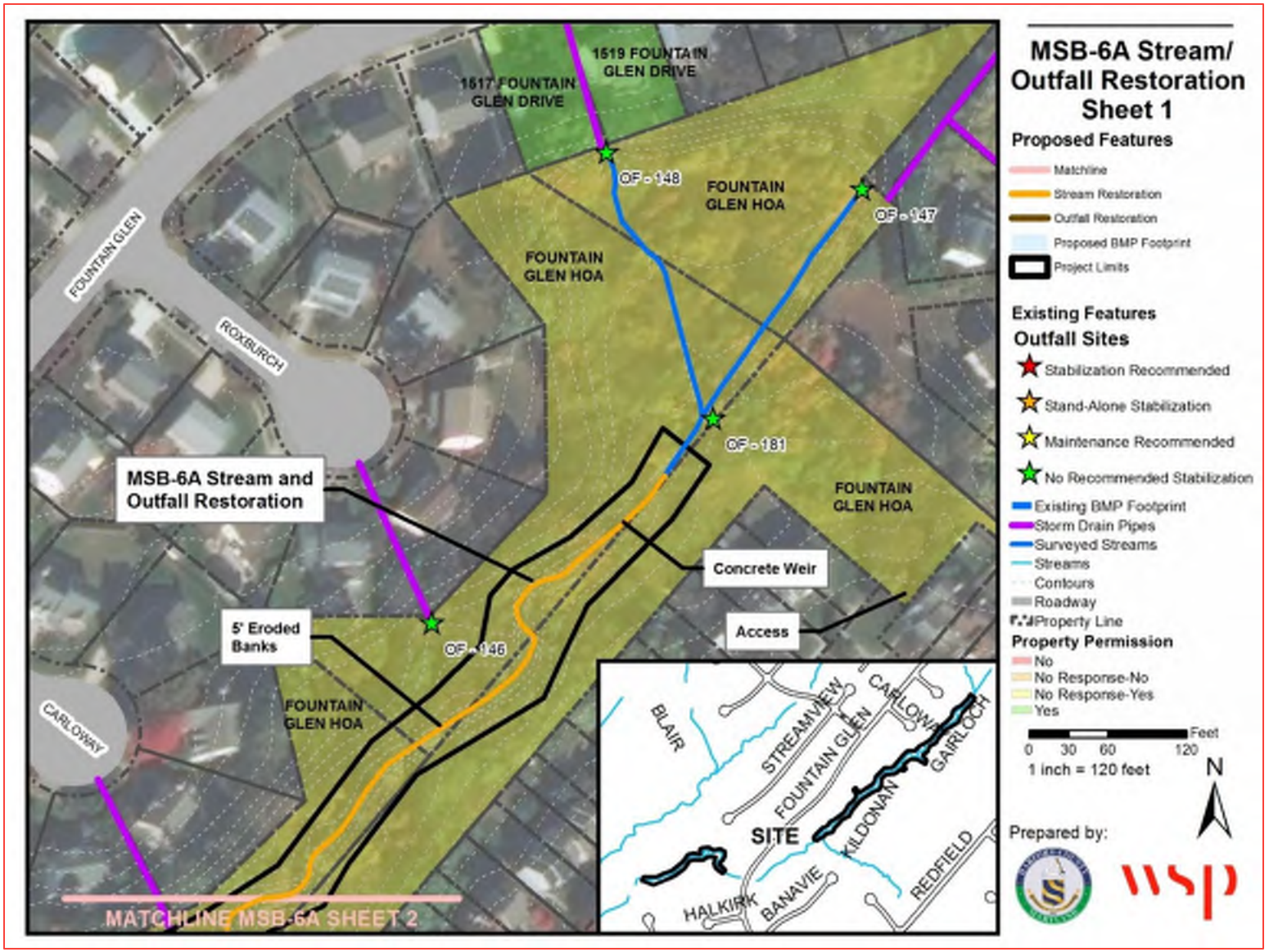

Figure C-95: Site Location and Proposed Project Plan for MSB-6A Stream Restoration (Sheet 1 of 4)

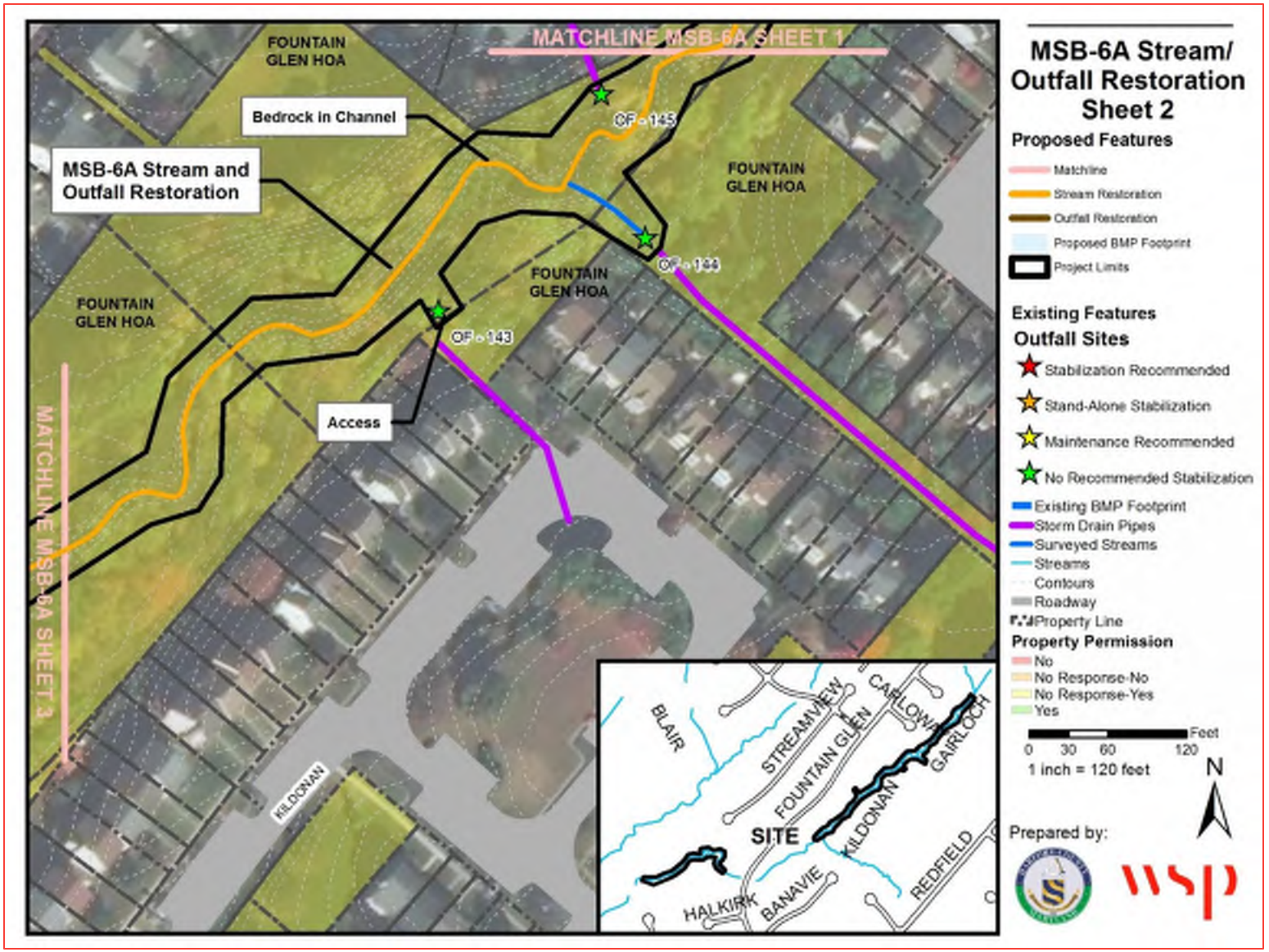

Figure C-96: Site Location and Proposed Project Plan for MSB-6A Stream Restoration (Sheet 2 of 4)

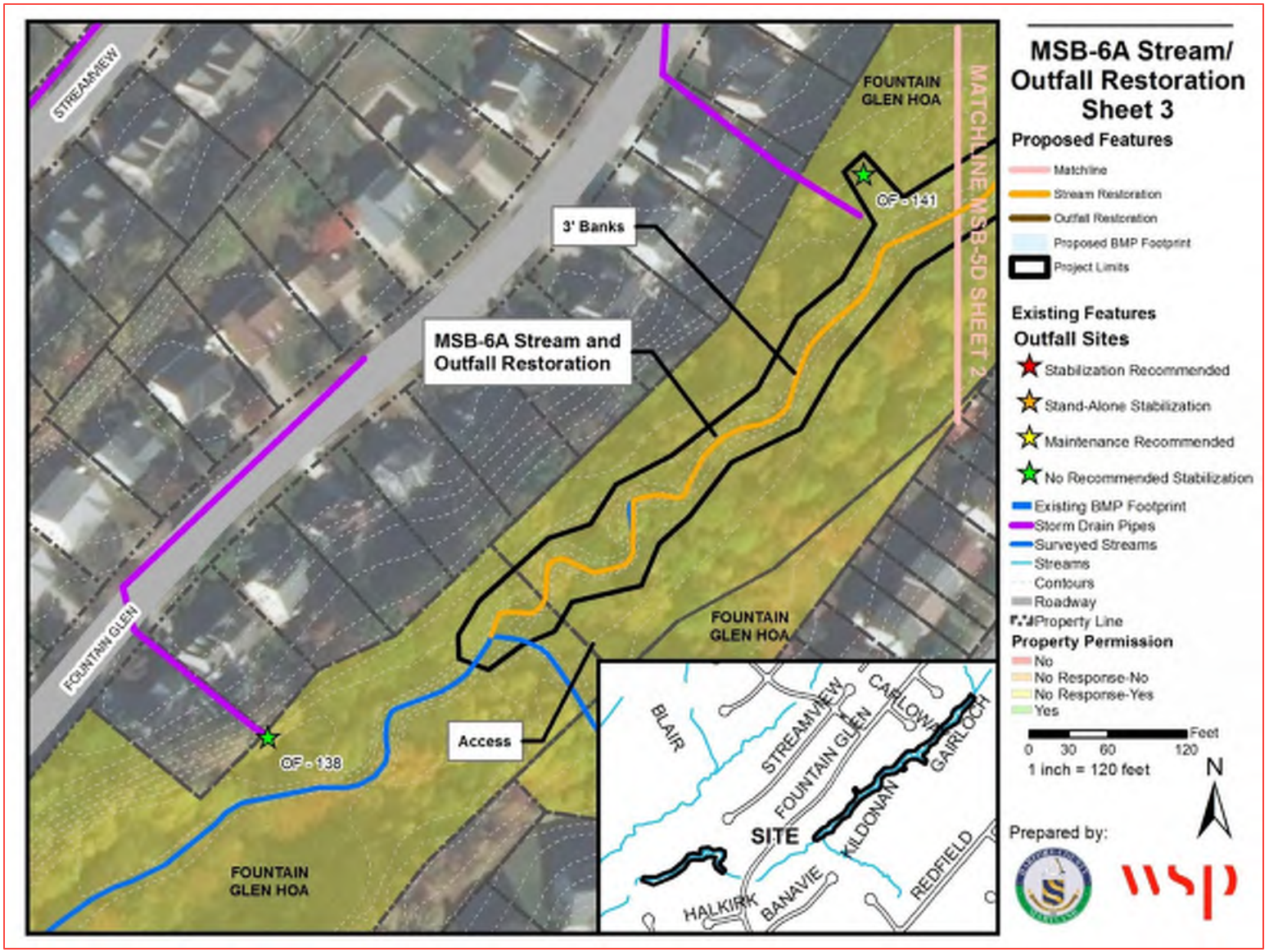

Figure C-97: Site Location and Proposed Project Plan for MSB-6A Stream Restoration (Sheet 3 of 4)

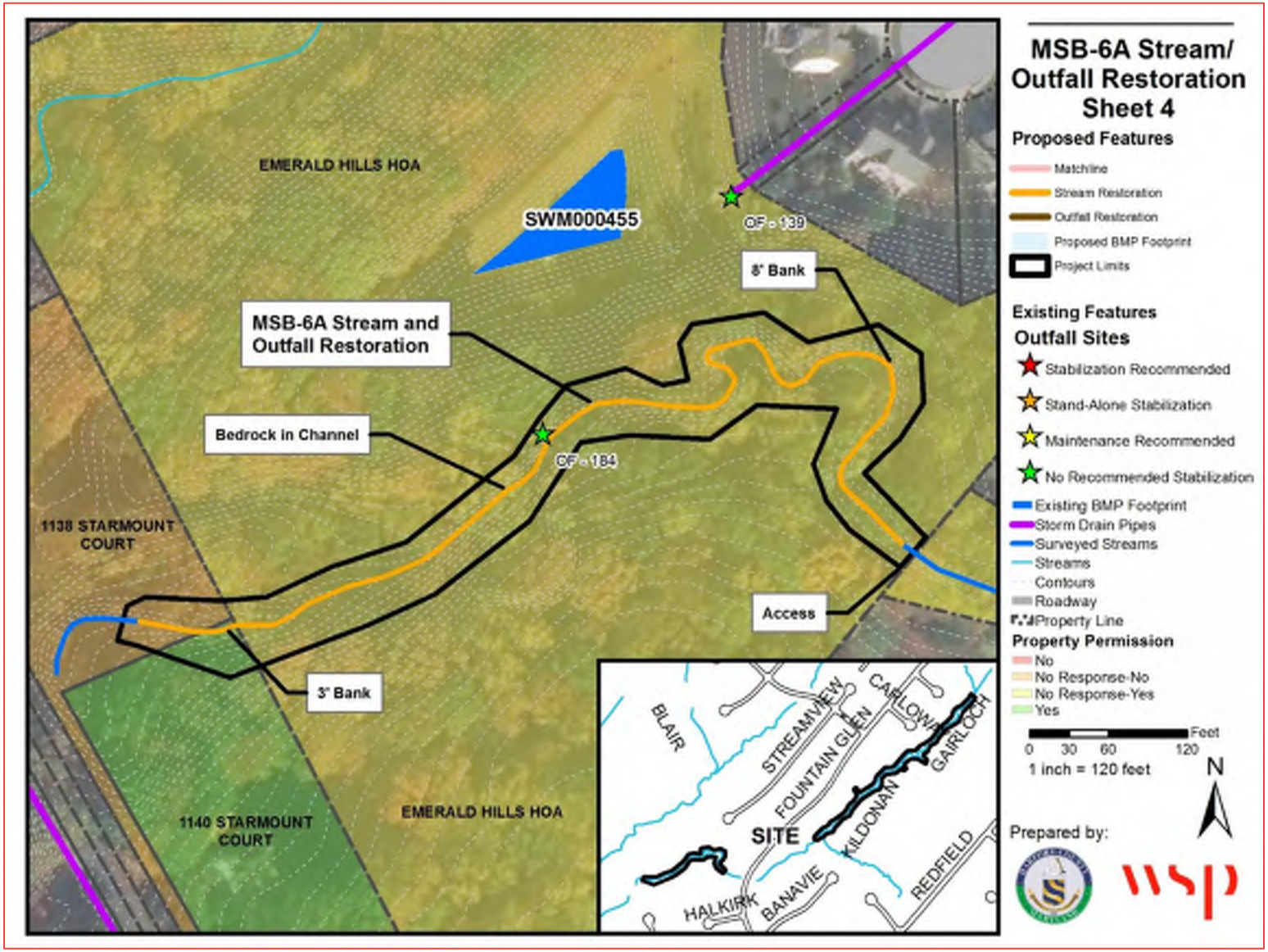

Figure C-98: Site Location and Proposed Project Plan for MSB-6A Stream Restoration (Sheet 4 of 4)