
I. Introduction

On behalf of the City of Amesbury Department of Public Works (Amesbury DPW), Pare Corporation (Pare) submits this Notice of Intent (NOI) under the Limited Project provisions of 310 CMR 10.53(3)(f) and (i) and the Amesbury Wetland Ordinance and Regulations (the Ordinance) for the proposed Friend Street Drainage Improvements project.

The City is proposing drainage improvements along a storm drainage system between Lindberg Avenue and Pleasure Pond in the Amesbury Town Park. The intent of the project is to improve natural stream processes, eliminate ongoing flooding issues, and reduce the risk of infrastructure damage by accommodating larger storm flows. The proposed project includes the following elements:

- Replacement of the culvert beneath the driveway at 8 Lindburgh Avenue;
- Replacement of the culvert beneath Friend Street in the area bordering Carriage Grove Apartments;
- Replacement of the culvert through Town Park from Friend Street to the Upper Pleasure Pond;
- Installation of a new downstream headwall at the inlet to Upper Pleasure Pond; and
- Concrete and embankment repairs at the Upper Pleasure Pond Dam.

Wetland resource areas on the project site include Bank and Land Under Waterbodies associated with Pleasure Pond, as well as Bank associated with an unnamed intermittent stream channel. In addition, the project includes work within the 100-foot Buffer Zone. Due to the nature of the work, permanent and temporary impacts to freshwater wetlands and buffers are unavoidable, however the proposed work will provide substantial improvements to the stream corridor and alleviate ongoing flooding issues. The project will not result in an increase in impervious surfaces and the disturbed areas through Town Park will be restored to pre-existing conditions.

The following narrative discusses the project background and existing site conditions; demonstrates the need for the work; describes the proposed project and alternatives evaluated; discusses activity within jurisdictional areas; and demonstrates project compliance with the applicable regulatory provisions of 310 CMR 10.00 and the Ordinance. The existing site conditions and the proposed reconstruction are shown on plans entitled “*City of Amesbury Department of Public Works- Friend Street Drainage Improvements*” prepared by Pare Corporation, dated April 2024 (the “Project Plans”). The Project Plans are designated as Section 6 of this NOI.



II. Existing Site Conditions

a. 8 Lindbergh Avenue Driveway Culvert

The upstream culvert to be replaced as part of this project is located beneath the driveway to the residence at 8 Lindbergh Avenue, and crosses between 8 and 10 Lindbergh Avenue. It is currently set within a stone pile found at the toe of a bank and consists of an 18" CMP pipe that crosses under the driveway. Currently there is both a water and sewer line service feed traveling underneath the culvert that will have to be dealt with as part of the project. H&H analysis of the culvert revealed that the existing culvert has limited hydraulic capacity and results in driveway flooding and overtopping during storm events greater than the 1-year event (2.7" of rain).

b. Friend Street Culvert & Amesbury Town Park Culvert

This culvert passes the stream beneath Friend Street to Amesbury Town Park adjacent to the Carriage Grove Apartments. This culvert consists of 24" HDPE drain pipe extending beneath the roadway. There is an existing 12" water main that crosses under the existing culvert just beyond the edge of the concrete sidewalk on the north (upstream) side of Friend Street as well as a 2" gas line just beyond the edge of the sidewalk on the south (downstream) side that will have dealt with as part of this project. The culvert feeds into a 30" RCP/CMP drain line that extends approximately 700 linear feet through the Town Park that discharges into Upper Pleasure Pond. H&H analysis of the drainage system revealed that the existing system has limited hydraulic capacity and results in flooding of the parking lot of the Carriage Grove Condominiums as well as along Friend Street during storm events greater than 2-year event (3.4" of rain)

c. Upper Pleasure Pond Dam

A dam impounds the upper portion of Pleasure Pond and discharges flow to the lower portion of the pond via a concrete spillway. A timber foot bridge provides pedestrian access over the spillway. Pare's recent inspections at the dam revealed some surficial deficiencies at the dam including concrete deterioration at the spillway and training walls as well as low areas left and right of the spillway prone to overtopping flow.

d. Wetlands and Floodplain

Wetland resource areas present in the vicinity of the project site include the Banks, Bordering Vegetated Wetlands (BVW), and Land Under Water (LUW) associated with the intermittent stream and Pleasure Pond. A majority of the site located outside of delineated wetlands is located within the 100-foot Buffer Zone. Wetlands are described in greater detail in the Wetland Delineation Report, which is included as Section 5 of this Notice of Intent.



According to the FEMA Flood Insurance Rate Map (FIRM) for the town of Amesbury, Massachusetts (Community Panel No. 25009C0102F, effective 4/11/2022), there is currently no 100-Year Floodplain mapped within the work area.

e. Other Environmental Considerations

According to the most recent available MassGIS data, no certified or potential vernal pools, Outstanding Resource Waters, Priority or Estimated Habitats of Rare Species/Wildlife or Areas of Critical Environmental Concern are located on or in the vicinity of the site.

According to the Massachusetts Historical Commission (MHC) MACRIS interactive map, one portion of the site is located within a mapped historical area. The proposed work on the culvert in Amesbury Park as well as the repairs on the Pleasure Pond Dam fall into historic area “AME.E” which is known as the Highlands Area.



III. Proposed Work

The City proposes drainage improvements along the length of stream corridor between Lindbergh Avenue and Pleasure Pond. The project includes replacement of two hydraulically undersized crossings as well as improvements to address the storm damage at the upper dam at Pleasure Pond. Each element of the proposed project is described below.

a. Culvert Replacement- Lindbergh Avenue

The existing driveway culvert at 8 Lindbergh Avenue will be replaced with a larger culvert designed to adequately accommodate storm flows. The existing 18" CMP pipe will be replaced with a 4'X3' precast concrete culvert designed to accommodate up to a 500-year storm event. The culvert will be placed on top of 6" of crushed stone. During construction, temporary water and sewer connections will be made to 8 Lindbergh Avenue until work is complete, and permanent sewer and water lines connecting to the property will be installed through the culvert. Stream bed fill will be placed at the upstream and downstream ends of the culvert and the slopes on both the left and right side of the culvert will be regraded with riprap scour protection. Upon completion of grading all exposed surfaces otherwise to be treated shall be covered with a minimum of 6 inches of loam and seeded. Additional mulch shall be applied as necessary to provide temporary stabilization until permanent vegetation cover is established.

b. Culvert Replacement- Friend Street and Amesbury Town Park

The existing 24" HDPE drainpipe culvert at Friend Street will be replaced with a 48" HDPE conduit on top of 6" of crushed stone. During construction a 12" water line on the north side of Friend Street by the spillway and a 2" gas line found on the opposite side of the street will be temporarily rerouted until permanent reinstallation is possible. For this project it is proposed that the water main be installed underneath the new culvert and the gas line be reinstalled above it (See Page 5.0 of plans for further detail). The existing headwall will be replaced with a precast concrete wingwall with a screen.

Downstream of Friend Steet, the existing rusted 30" CMP extending between Friend Street and Upper Pleasure Pond will be replaced 48" HDPE drain line placed on top of 6" of crushed stone. The existing headwall at the outlet to Upper Pleasure Pond will be replaced with a precast concrete wingwall with a screen. Riprap scour protection will be installed at the inlet to the pond. Following construction, excavated areas will be restored to pre-existing conditions and seeded.

c. Upper Dam at Pleasure Pond

Repairs to the Upper Pleasure Pond Dam will include repairs to deteriorated areas of concrete along the spillway walls, removal of unwanted vegetation from the dam embankment, regrading of eroded embankment slopes, and installation of riprap slope protection. Cofferdams to be installed at the upstream and downstream ends of the spillway will allow for completion of the work in dry conditions.



d. Channel Restoration and Bank Stabilization

In order to install the proposed box culverts and crushed stone foundation, organic materials within the influence of the structure must first be excavated to then embed the foundation, and partially infill the culvert to provide the desired riverbed substrate conditions. Areas of excavation will be performed in the dry behind contractor designed cofferdams, and the riverbed material will be backfilled into the stream channel after work is complete. Proposed bank stabilization in the vicinity of the culvert consists of riprap, and all exposed areas will be composted with mulch and seeded to provide a vegetated surface.

e. Erosion and Sedimentation Control

Erosion and sedimentation controls will consist of perimeter controls (compost filter socks) as well as cofferdams with turbidity barriers as shown on the Project Plans. The contractor will be responsible for installing and maintaining all erosion controls as indicated in the contract documents. Installation of stream bypass systems will be put in place to divert water from proposed work area.

f. Traffic Management

Replacement of the Friend Street culvert will require temporary closure during construction. A proposed detour will run southeast on Highland Street and then turn left heading northeast on Sparhawk Street before turning left again and heading north on School Street until reconnected with Friend Street.



IV. Wetland Impacts and Regulatory Compliance

Due to the nature and location of the proposed work, the project will result in unavoidable impacts to various wetland resource areas. Permanent and temporary alterations are proposed to Bank and Land Under Waterways. In addition, the proposed work located outside of the pond will occur within the 100-foot Buffer Zone. Throughout the design, significant efforts have been made to avoid or minimize permanent impacts to the extent practicable. Impacts to the various resource areas in the project site, and compliance with the applicable performance standards, are portrayed in Table 1, below and further described in the following sections.

Table 1: Resource Area and Buffer Zone Impacts

Impact Type	Bank (delineated edge of Intermittent Stream or Pond) in If			Land Under Waterbodies (Pond) or Land In Intermittent Stream in sf			100' Buffer Zone		
	Temporary	Permanent	Total	Temporary	Permanent	Total	Temporary	Permanent	Total
Lindbergh Ave Culvert	60	56	116	475	116	591	448	159	607
Friend Street Culvert	26	39	65	225*	16*	241*	291	123	414
Pleasure Pond Dam	147	41**	188	2,530	0	2,530	133	223	356
Total	233	136	369	3,230	132	3,362	872	505	1,377

* repairs to manmade bank (concrete spillway walls)

**68 sf temporary/15 sf permanent impact to intermittent stream; 157 sf temporary/1 sf permanent impact to LUW (pond)

***543 sf temporary/131 sf permanent impact to intermittent stream; 2,687 sf temporary/1 sf permanent impact to LUW (pond)

a. Bank

The proposed culvert improvements will result in approximately 95' linear feet of permanent impacts to Bank upstream and downstream of the culverts located on Lindbergh Avenue, Friend Street and within Amesbury Town Park. These impacts will result from placement of vegetated rock fill slope protection at the bank upstream and downstream of each culvert. In addition, repairs to the deteriorated concrete walls at the dam will result in improvement of approximately 41 linear feet of manmade Bank. While this work will permanently change the character of the Bank, the work is proposed to restore and preserve the physical stability of the Banks in areas damaged by erosion and scour from flooding and storm damage. The modified rock fill slope protection at the culverts will be enhanced with composted mulch and seed to provide a more naturalized condition along the Bank.

Construction access, control of water and installation of erosion and sedimentation controls will result in up to 233 linear feet of additional, temporary impacts to Banks within the work area. Upon completion of construction, any disturbed areas will be stabilized and allowed to naturally revegetate.



None of the proposed temporary or permanent Bank impacts will adversely affect the physical stability of the Bank, ground water and surface water quality, or whatever capacity the Bank may have to provide breeding habitat, escape cover and food for fisheries. Most of the Bank consists of previously disturbed areas immediately surrounding the culverts and maintained slopes along the dam embankment with limited value for wildlife. Pursuant to the Limited Project provisions of 310 CMR 10.53(3)(l), the applicant requests that the Conservation Commission waive the requirement for a wildlife habitat evaluation for work affecting more than 50 linear feet to Bank.

b. Land Under Waterbodies (Pond)

The proposed improvements to Pleasure Pond Upper Dam are located at or above the delineated Bank and avoid permanent alterations to Land Under Waterbodies (LUW) within the pond. The proposed riprap installation at the Friend Street Culvert's inlet to the west side of the pond will result in approximately 1 square foot of permanent LUW impacts. Temporary control of water will result in up to 2,687 square feet of temporary impacts to the pond which are necessary to complete the work in dry conditions.

The proposed limits of work also include 131 square feet of permanent impacts of land below the delineated bank of the intermittent stream, including 116 at the Lindbergh Avenue culvert and 16 at the Friend Street culvert. These impacts will result from regrading the stream bottom to facilitate installation of larger culverts, channel bottom restoration in the location of the replacement culverts, and the installation of modified rock fill protection downslope from the Banks to stabilize the slopes. Up to 543 square feet of temporary impacts will result from control of water, erosion and sediment controls, and access to the work area.

The culvert designs and stream bottom grading/restoration will not result in any reduction in the water carrying capacity of the channel. The work is not expected to result in any adverse impact to ground and surface water quality. Breeding habitat, escape cover, and food for fisheries that may be present will not be compromised by the installation of the new culverts.

The project complies with the municipal Performance Standards for LUW established in Section 17.1(d) of the Amesbury Wetland Regulations, as follows:

(1) Proposed work shall not cause a significant adverse effect or cumulative adverse effect upon the wetland values of Land Under an Inland Water Body.

Only approximately 1 square foot of permanent alterations to LUW is proposed and is necessary to provide scour protection at the inlet to Pleasure Pond. The temporary alterations are the minimum necessary to complete the proposed dam repairs in dry conditions. The remainder of the permanent impacts within water are to occur within the intermittent stream channel in the location of the culvert repairs, which will not result in any loss of the resource area and will result in a minor net increase in Land Under Waterways with the widening of the culverts.



(2) Notwithstanding the above provisions, no project may be permitted which will have any adverse effect on specified habitat of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.59.

According to the most recent mapping from NHESP, no mapped Priority or Estimated Habitats of state-listed wildlife are located within the project area.

(3) Performance standards for proposed work or activities within the buffer zone to Land Under an Inland Water Body are specified in AWR 20.0.

These standards for Buffer Zone are addressed in Section d, below.

(4) The Commission may impose such additional requirements as are necessary to protect the wetland values protected under the Ordinance.

Noted.

c. 100-Foot Buffer Zone

A majority of the project area is located within the 100-foot Buffer Zone associated with the Banks and BVW areas on the site. Permanent alterations within the Buffer Zones include the impacts discussed in the previous sections as well as additional grading, full depth pavement reconstruction, Additional temporary alterations to the Buffer Zone may result from construction vehicle access for the aforementioned work and installation of erosion controls.

The project complies with the municipal Performance Standards for 100-foot Buffer Zone established in Section 20.0(d) of the Amesbury Wetland Regulations, as follows:

See(1) The intent of the Conservation Commission is to move all structures and activities as far away as possible from any Resource Area, in order to protect the wetland values of Resource Areas.

Due to the nature of the project, work within and immediately adjacent to resource areas is unavoidable. However, this work has been minimized to the extent practicable to achieve the project purpose and will result in an improvement over existing conditions. Areas of temporary disturbance within the buffer zone will be restored to pre-existing conditions.

(2) Except as otherwise specified, Resource Area buffers shall be retained and maintained in a naturally vegetated condition. Where buffer disturbance has occurred during construction, revegetation with native vegetation may be required.



Proposed buffer zone alterations are confined to existing disturbed areas surrounding two hydraulically undersized culverts, one which extends beneath a residential driveway, and the other which extends beneath Friend Street and through maintained areas of Amesbury Town Park. Existing conditions within the buffer zone will be restored. Addition of buffer zone vegetation plantings within these areas is not compatible with current uses.

(3) The Commission may require that already-altered buffer zone be restored in order to protect or improve Resource Area values. Restoration means planting native vegetation, grading, correcting site drainage, removing debris, or other measures which will improve, restore and protect the wetland values of the Resource Area.

The proposed drainage improvements will benefit resource areas and associated buffer zones by improving natural stream processes, eliminating ongoing flooding issues, and reducing the risk of damage by accommodating larger storm flows.

(4) Notwithstanding the above provisions, no project may be permitted which will have any adverse effect on specified habitat of rare vertebrate or invertebrate and rare plant species, as identified by procedures established pursuant to 310 CMR 10.59.

No mapped habitats of rare species are located on or near the project site.

d. Massachusetts Stream Crossing Standards

The project complies with the Massachusetts Stream Crossing Standards to the maximum extent practicable given the site constraints and existing roadway and driveway infrastructure along the stream corridor. Compliance with the standards is described in Table 2, below.



Table 2: Compliance with the Massachusetts Stream Crossing Standards

Standard	Compliance Commentary
1. TYPE OF CROSSING	
• General: Spans (bridges, 3-sided box culverts, open bottom culverts or arches) are strongly preferred.	Lindbergh Avenue Driveway Crossing consists of a proposed 3ft (tall) x 4ft (wide) precast cement concrete box culvert and will replace an 18-inch diameter corrugated metal pipe (CMP) beneath a residential driveway. A four-sided box culvert was selected as the most economical and least disruptive structure for the project location, terrain, and environmental resources. The 3 ft x 4 ft box culvert provides for an increased cross section flow area (gross) 6.7 times the original cross-section flow area of the 18-inch CMP. A four-sided box culvert provides a uniform bottom surface area to transfer vehicle loading / weight to the subsurface soils at lower pressures. In addition, the four-sided culvert with integral bottom will eliminate the potential for intermittent streambed downcutting. Alternatively, and three-sided box culvert with open bottom or standard vehicle bridge requires foundations or footings, abutments, a formal bridge structure spanning the crossing, and would result in greater temporary and permanent impacts to the surrounding terrain, including fill with associated flood volume losses (non FEMA Floodplain). Friend Street Crossing/Town Park Conduit is a 770-foot long underground stormwater conveyance between the inlet at Friend Street and outlet at Pleasure Pond. The proposed 48-inch diameter conduit will replace an undersized or hydraulically inadequate 24-inch and 30-inch diameter pipe or conduit system. The Friend Street Crossing and Amesbury Park Conduit primarily functions as a storm sewer (drain) system and routes intermittently occurring stream flows from the upgradient area (north of Friend Street) to Pleasure Pond. A typical bridge crossing could not be applied as a solution for the length of conduit. Similarly, an open bottom or 3-sided culvert would likely be problematic with intermittent stream flow down-cutting and high potential for subsurface soil removal (internal erosion) and downstream sediment deposition.
2. EMBEDMENT	
• All culverts should be embedded (sunk into stream) a minimum of 2 feet, and round pipe culverts at least 25%.	Lindbergh Avenue Driveway Crossing: The 2-foot embedment requirement for the four-sided 3 ft (tall) x 4 ft (wide) box culvert could not be met due to the presence of the residential water and sanitary sewer services to 8 Lindberg Ave. However, the box culvert interior bottom will be embedded 0.77 feet and will fill with natural sediment or intermittent streambed material with the passage of time and rain or meltwater events with resulting flows within the intermittent stream but still provide an increased useful or dynamic cross section flow area 5 times the original.
• If pipe culverts cannot be embedded this deep, then they should not be used.	



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- When embedment material includes elements >15 inches in diameter, embedment depths should be at least twice the D84 (particle width larger than 84% of particles) of the embedment material.

Friend Street Crossing/Town Park Conduit: The proposed conduit inlet just north of Friend Street will consist of a 48-inch diameter (round) HDPE pipe and will be embedded 25% and therefore meets the Stream Crossing Standard requirement. The current inlet invert elevation is 95.95 or essentially 96 (+/-) and the proposed inlet invert elevation is 95.0, resulting in a 12 inch or 1 ft lower inlet elevation and 1 ft submergence / 4 ft diameter pipe and complies with 25% pipe embedment.

The remaining conduit from Friend Street to Pleasure Pond is considered as storm sewer or drainage conveyance system and the conduit and extended location are not considered as a typical stream crossing. However, as best as practicable, the 48-inch diameter conduit outlet at Pleasure Pond will be lowered 2 feet from current outlet invert.

The elevation of the 48-inch diameter (round) pipe outlet will be lowered from the existing invert of 79.0 to a proposed elevation of 77.0. The existing outlet pipe is projected or perched 2 feet above the average Pleasure Pond impoundment elevation and comply with the requirement as best as practicable.

3. CROSSING SPAN

- General: Spans channel width (a minimum of 1.2 times the bankfull width of the stream).

Lindbergh Avenue Driveway Crossing: Meeting this standard is not feasible due to an 8 ft to 10 ft or more span requirement and the need to minimize the temporary and permanent terrain and resource impacts. Typically, the wider a box culvert is beyond a square cross section, the thicker or more robust the support walls and top and bottom slabs are required to be. This results in an increase of final proposed elevation surface (fill). However, the proposed 3' (tall) by 4 ft (wide) span will replace an 18" CMP with a 4-foot wide box culvert providing a substantial improvement over existing conditions. The culvert is of sufficient size based on hydraulic analyses that demonstrate that the proposed box culvert span results in little to no change in water surface elevation from upstream to downstream of the crossing, but maintains the final surface grading or elevations the same as existing (minimal fill).

- Optimum: Spans the streambed and banks (at least 1.2 times bankfull width) with sufficient headroom to provide dry passage for wildlife.

Friend Street Crossing/Town Park Conduit:

As previously described, the remaining conduit from Friend Street to Pleasure Pond is considered as storm sewer or drainage conveyance system and the conduit and extended location are not considered as a typical stream crossing.

The Friend Street conduit of 48-inch diameter selected is based on hydrologic and hydraulic modeling.

Furthermore, although the intermittent stream upgradient or north of the Friend Street crossing varies between 5 ft and 6.5 ft wide or more, no bank exists for the closed conduit storm sewer system from the inlet at Friend Street to discharge point or outlet to Pleasure Pond within Amesbury Town Park. A required 1.2 x bankfull width would result in an interior span of 6 ft to 8 ft (or more) and would result in a cost prohibitive project.

In addition, it is highly unlikely that wildlife habitat would migrate through a 3 or 4-sided culvert for the 770 ft distance even with the meeting of the 1.2 times bankfull width requirement.



4. OPENNESS

- **General:** Openness ratio (cross-sectional area/crossing length) of at least 0.82 feet (0.25 meters). The crossing should be wide and high relative to its length.
- **Optimum:** Openness ratio of at least 1.64 feet (0.5 meters) and minimum height of 6 feet. If conditions significantly reduce wildlife passage near a crossing (e.g., steep embankments, high traffic volumes, and physical barriers), maintain a minimum height of 8 feet (2.4 meters) and openness ratio of 2.46 feet (0.75 meters).

Lindbergh Avenue Driveway Crossing

Cross Section Area = 12 sf (4 ft x 3 ft)

Crossing Length = 50 feet

$$OR = A/L = 12 \text{ ft}^2 / 50 \text{ ft} = 0.24 \text{ ft}$$

The proposed 3 ft (tall) x 4 ft (wide) 4-sided box culvert will be 50 feet long. The proposed length is 10 feet shorter than the existing 60-foot long 18-inch CMP.

In order to meet the minimum OR of 0.82 with a 3 ft x 4ft cross section flow area, the required culvert length is 14 feet. However, the existing driveway is 14 feet wide and the upgradient and down gradient front yards provide an additional combined 46 feet of length that is not current bank or part of the intermittent stream.

Similarly, the optimum OR cannot be met as that would require a culvert length of 7.3 feet, which would not allow for a driveway with sufficient width and vehicle passage and is therefore infeasible.

In addition, A minimum height of 6 feet is impractical as would require 3 ft to 5 ft (peak), elongation of the driveway from Lindbergh Ave to the residential dwelling (for the ascent and decent) and considerable fill and corresponding loss of floodplain (non FEMA).

Please note that no significant barriers to wildlife passage across the surface exist for the current 18-inch diameter by 60 ft long CMP but may exist for riverine wildlife. However, for the proposed 3 ft x 4 ft x 50 ft long box culvert, riverine and woodland wildlife habitat passage across the surface would occur unimpeded.

Friend Street Crossing/Town Park Conduit:

Cross Section Area = 1.77 ft² (48-inch diameter)

Crossing Length = 770 feet

$$OR = A/L = 1.77 \text{ ft}^2 / 770 \text{ ft} = 0.0023 \text{ ft}$$

As previously described, the remaining conduit from Friend Street to Pleasure Pond is considered as storm sewer or drainage conveyance system and the conduit and extended location are not considered as a typical stream crossing.

In order to meet or comply with the minimum OR or optimum OR, the required cross-sectional area would need to be 630 ft² and 1432 ft², respectively, which equates to 25 ft 25 ft and 37 ft x 37 ft cross sectional box culvert areas. Therefore, it is inappropriate to apply the Openness Ratio to the 770-foot long conduit.

5. SUBSTRATE

- **Natural bottom substrate should be used within the crossing and it should match the upstream and downstream substrates. The substrate and design should resist displacement during floods and maintain an appropriate bottom during normal flows.**

Substrate is intended to match conditions upstream and downstream of the crossing. The banks under the culvert and immediately upstream and downstream will be lined with a modified rockfill (to reduce potential of surface soil erosion). Channel substrate will be restored to its native state.



6. WATER DEPTH AND VELOCITY

- Water depths and velocities are comparable to those found in the natural channel at a variety of flows.

The Crossings were designed to match existing upstream and downstream flood elevations and flow rates as much as practicable. Therefore, flows at the crossing will be similar to those immediately upstream and downstream of the crossing under most flow conditions.

Lindbergh Avenue Driveway Crossing

Existing Flows and Velocities:

Year Rain Event	2	10	25
Q (cfs)	8.2	8.8	8.9
V (fps)	4.7	5.0	5.1

Proposed Flows and Velocities

Year Rain Event	2	10	25
Q (cfs)	16.1	40.0	56.4
V (fps)	3.5	5.9	6.5

It is important to note and understand that the 18-inch diameter culvert at 8 Lindbergh Avenue is hydraulically inadequate and the front yard and surrounding terrain repeatedly floods rather than flow being fully routed through the conduit; that is, flow by-passes the conduit for the existing condition. The flows increase for the proposed condition as a larger percentage of flow is fully routed through the conduit rather than around it.

Friend Street Crossing/Town Park Conduit:

Existing Flows and Velocities:

Year Rain Event	2	10	25
Q (cfs)	13.8	19.2	19.7
V (fps)	4.4	6.1	6.3

Proposed Flows and Velocities

Year Rain Event	2	10	25
Q (cfs)	16.5	40.9	57.5
V (fps)	4.1	5.3	5.9

Similarly, the existing 24-inch diameter conduit at Friend Street is hydraulically inadequate and depending on the rain event, intermittent stream flows will create a backwater or flooding condition north of the Friend Street conduit inlet, further exacerbating the flooding condition at 8 Lindbergh Avenue. As can be seen above, the flows increase for the proposed conditions, but velocities are reduced and a larger percentage of flow is routed through the conduit and stormwater conveyance system rather than a backwater and flooding conditions at the inlet.

