APPENDIX ‘B’

HYDROLOGIC AND HYDRAULIC ASSESSMENT

Happyland Park Crossing - Dugald Drain Crossing Replacement Hydrologic and Hydraulic Assessment

January 2014
Rev 2

City of Winnipeg Public Works

Bruce Harding Consulting Ltd

Happyland Park Crossing - Dugald Drain Crossing Replacement Hydrologic and Hydraulic Assessment

PROVINCE OF MANITOBA
ORIGINAL SIGNED BY
W. B. J. HARDING
Jan 24, 2014
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
Bruce Harding Consulting Ltd.
No. 4652 Expiry: April 30, 2014

Prepared by: Bruce Harding, P.Eng.

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1 Introduction

This report summarizes the results of our hydrologic analysis and hydraulic sizing for a replacement crossing of Dugald Drain within Happyland Park in the City of Winnipeg. The location of the site is indicated on Figure 1. The existing concrete pipe crossing has reached the end of its service life and requires replacement.

Pertinent features of the site are as follows:

- Jurisdiction - City of Winnipeg
- Watercourse - Dugald Drain
- Flow Direction - West
- Designation of Drain Map - No. 9
- UTM Coordinates - 636360E, 5527180N (Zone 14)
- Total Drainage Area - 9.8 km^2

Four options for the crossing replacement have been developed and assessed as follows:

- Large diameter precast concrete pipe without headwalls
- Reinforced concrete box culvert with headwalls
- Clear span footbridge
- Double precast concrete pipes without headwalls

The reach of the Dugald Drain near the crossing has been designated as Type B - simple fish habitat with indicator species by Fisheries and Oceans Canada[1]. The designation is due to the proximity of the drain to the Seine River, which is approximately 140 m downstream of the crossing. On that basis, the design of the proposed replacement crossing must therefore adhere to the Manitoba Stream Crossing Guidelines[2] with respect to providing fish passage.

It is unlikely that the Dugald Drain would be considered navigable by Transport Canada; therefore no provisions under the Navigable Waters Act have been provided at this location. Note however that it is recommended to get a judgement on navigability prior to completing the final design.

Additional details with respect to the hydrologic assessment and the hydraulic sizing of the replacement structure options are summarized in the following sections.

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1 "Fish Habitat Classification for Manitoba Agricultural Watersheds", Map 062H14, April 2012, Fisheries and Oceans Canada.
2 "Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat", Manitoba Natural Resources –Fisheries Department and the Canadian Department of Fisheries and Oceans, May 1996

2 Flood Hydrology

The contributing drainage area of Dugald Drain to the Happyland Park crossing is approximately 9.8 km^2. Flood estimates for the Dugald Drain are challenging to accurately estimate due to the wide range of land use within the drainage area which ranges from rural residential to industrial/commercial, but also due to the types of land drainage employed. Land drainage is provided primarily via open drainage channels, but also by an extensive network of storm sewers. This is further compounded by the fact that the open drainage channel of the Dugald Drain is not large, with a limited discharge capacity due to several factors including the geometric template, but also the large number of culvert crossings.

Reference has been made to a crossing replacement study for the Marion Street Crossing of the Dugald Drain[3]. Detailed hydrological assessments of the drainage network was undertaken using the urban hydrological modeling program Storm Water Management Model (SWMM). The SWMM model was developed primarily for assessing urban runoff and drainage following rational hydrological techniques. SWMM allows for routing the rainfall event through the various forms of urban drainage infrastructure, including open drains, culverts and storm sewers. The 2009 AECOM report evaluated the Marion Street Crossing for a 25 year rainfall event followed by a subsequent 5 year rainfall (4 days lagged). The peak discharge at the Happyland Park crossing was estimated at 5.4 m^3/s, however note this is a peak value and not a daily average as typically assumed. The daily average would be approximately 2.0 m^3/s. The other item of note is that typically crossings of this nature are designed for a flood event equivalent to a specific probability of occurrence which is typically much higher such as a 2% or 1% event (50 year or 100 year event) versus the 4% (approximately) that was estimated at the Marion Street crossing.

Hydrology for open channels is often derived using rational or regional analysis techniques utilizing the drainage area and the application of appropriate discharge coefficients and weighting factors. The merging of these two methodologies (SWMM versus open channel rational/regional methods) creates the challenge as they aren't entirely comparable. However they both provide a means to evaluate and size the replacement crossing. On that basis, hydrology derived by both methods will be used as part of the assessment. Table 1 summarizes the discharge estimates

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3 "Preliminary Design Report, Marion Street Crossing of Dugald Drain Replacement", May 13, 2009 AECOM

Table 1
Happyland Park Crossing - Dugald Drain
Flood Discharge Estimates

Probability	**Flood Discharge Estimate (m^3/s)**
50% Discharge	1.2 *
1% Discharge	6.2 *
25 Year + 5 Year Rainfall (Peak)	5.4 **
3DQ10	2.2*

1 Rational Methods
2 AECOM 2009 Marion Street Dugald Drain Crossing replacement study

If a watercourse is considered fish habitat, then a crossing of the watercourse should not restrict upstream fish passage during a spawning migration period for flows up to a specified fish passage discharge. The estimate of the 3 day delay discharge with a 10% probability of exceedence (3DQ10), as summarized in Table 1, is typically selected as the fish passage discharge.

The backwater effects of elevated levels on the Seine River, which are typically a function of high levels on the Red River have a large influence on the hydraulics of the Dugald Drain at this location. The Red River during periods of high flow backwaters the lower Seine River for a considerable distance upstream of the confluence due to the flat grade of the Seine River. Accordingly, the backwater influence translates upstream into the tributaries of the Seine River including the Dugald Drain. For this assessment it has been assumed that the flood discharges could occur over a wide range of Seine River levels from non-Red River influenced levels to heavily backwatered levels up to that equivalent to the Flood Protection Level of 229.40.

3 Hydraulic Assessment – Existing Conditions

The existing Happyland Park crossing of the Dugald Drain consists of a single 2.7 m diameter by 7.9 m long precast concrete pipe with concrete headwall/wingwalls. As indicated, the existing crossing has reached the end of its service life and requires replacement. Refer to the appended site photographs.

A steady-state backwater model of the Dugald Drain within the crossing reach was developed to assess the hydraulic conditions of the waterway, the existing crossing and the proposed replacement crossing options. The backwater model extends approximately 200 m upstream from the Seine River to the downstream (west) side of Archibald Street. The hydraulic analysis for this reach of the Dugald Drain was undertaken using the US Army Corps of Engineers River Analysis System HEC-RAS model. The HEC-RAS model is a one-dimensional backwater model, which is considered to be the universal standard for computing steady-state water surface profiles. The backwater model for this reach of the drain was developed using cross-sections, channel profiles and details of the existing crossing surveyed by Dillon Engineering in October 2013.

The backwater model has been developed to the level of detail required to estimate the relative effect of the proposed crossing. The model has not been calibrated to observed water levels during periods of high flow, and hydraulic parameters such as channel roughness have been selected based on observations, judgement and experience gained from similar projects.

The estimated water surface profiles for the Dugald Drain within the study area with the existing Happyland Park Crossing are shown on Figure 2. Table 2 summarizes the hydraulic assessment for the existing crossing.

Table 2
Happyland Park Crossing - Dugald Drain
Hydraulic Summary for Existing Crossing

Probability	Discharge (m^3/s)	Seine River Water Level (m)	Headloss (m)	Clearance to Culvert Soffit * (m)	Culvert Velocities (m/s)
50% Discharge	1.2	224.5 Low Seine River	0.09	2.1 clear	1.5
50% Discharge	1.2	225.4 12ft JAPSD	<0.05	2.0 clear	0.95
50% Discharge	1.2	227.2 18ft JAPSD	<0.05	0.25 clear	0.2
50% Discharge	1.2	229.4 FPL	<0.05	0.95 OT **	0.1
1% Discharge	6.2	225.4 12ft JAPSD	0.28	1.2 clear	2.75
1% Discharge	6.2	227.2 18ft JAPSD	<0.05	0.2 clear	1.05
1% Discharge	6.2	229.4 FPL	<0.05	0.95 OT **	0.3
25 Year + 5 Year Rainfall (Peak)	5.4	225.4 12ft JAPSD	0.26	1.35 clear	2.6
25 Year + 5 Year Rainfall (Peak)	5.4	227.2 18ft JAPSD	<0.05	0.22 clear	0.95
25 Year + 5 Year Rainfall (Peak)	5.4	229.4 FPL	<0.05	0.95 OT **	0.25
3DQ10	2.2	225.4 12ft JAPSD	0.14	1.85 clear	1.9
3DQ10	2.2	227.2 18ft JAPSD	<0.05	0.23 clear	0.4
3DQ10	2.2	229.4 FPL	<0.05	0.95 OT **	0.15

* - culvert soffit at approximately el 227.44 m

** - crossing overtopped

The existing crossing was assessed to determine if the structure, if rehabilitated, could meet the hydraulic and fish passage requirements. Rehabilitation would require the replacement of the headwalls and wingwalls, however the existing concrete pipe would be retained without alteration and adjustment of the invert. It was noted that the structure would satisfy the hydraulic design requirements; however, culvert velocities exceed the requirements for fish passage. Additionally, the culvert would not be embedded below channel grade which would also be a fish passage requirement for a replacement structure. The existing culvert diameter is comparable to one of the proposed replacement options (Option 1), however the proposed replacement structure has the culvert invert approximately 0.55 m lower, which includes 0.4 m embedment and rock substrate infill, which results in lower culvert velocities. Refer to the following sections which detail the design requirements for the crossing replacement.

4 Hydraulic Assessment – Proposed Crossing Replacement

4.1 General

Culvert and clear span bridge structures were considered for this location due to site geometry and the flow conditions observed at this location. The culverts considered for this location are sized to satisfy the hydraulic requirements, in addition to fish passage requirements. A clear span bridge structure was also developed to eliminate intermediate piers easing construction.

4.2 Hydraulic and Regulatory Design Criteria

The hydraulic design criterion selected for the replacement crossing are as follows:

- Design discharge – 1%.
- Maximum headloss of 0.3m during the passage of the design discharge.
- Culvert/bridge opening velocities less than 1.5 m/s for discharges up to the design discharge
- Underside of girder elevation or culvert soffit to remain approximately above water surface during passage of design discharge.

A maximum permissible fish passage velocity during the passage of the 3 day delay –10% fish passage discharge (3DQ10) will be required. For culvert(s) longer than 25 m, the velocity is limited to 0.8 m/s, while culverts shorter than 25 m have a limiting velocity of 1.0 m/s at the 3DQ10. Note that the limiting velocity requirement is typically only applied to culvert type structures and not bridge structures, therefore for this assessment the requirement will only be considered for the two culvert options. For the culvert options, the invert of the culvert has been recessed below the bottom of the drain and will be backfilled with a minimum 0.3 m thickness of granular/rock substrate to the streambed elevation.

The Dugald Drain has not been assessed for navigability, however it is unlikely that it would be judged as navigable as per Transport Canada. On that basis no provisions under the Navigable Waters Act are required for this proposed crossing, however the judgement that the drain is non-navigable should be confirmed prior to final design.

The underside of girder/soffit clearance requirement is typically based on either; minimizing the collection of debris or ice on the upstream side which has the potential to plug the structure, minimizing the lateral forces acting on the bridge, or minimizing the effects of uplift. Large debris or large ice runs capable of blocking the hydraulic opening however are limited in the drain and are therefore not of great concern with respect to the design. Additionally, girder/soffit submergence occurs as a result of backwater from the Seine and Red Rivers, not by high flows. On that basis, girder or soffit submergence is permissible at the design discharge.

4.3 Replacement Options

Three replacement options have been prepared including a large diameter concrete pipe option (without headwall), a reinforced concrete box culvert option and a clear span footbridge option. The options proposed are as follows:

Option 1 – Large Diameter Concrete Pipe

The proposed option 1 replacement structure for this site is as follows:

- Single 2.74 m diameter by 23 m long precast concrete pipe without headwalls (projecting from fill). Culvert set with 22 degree skew to pathway centreline.
- Culvert invert set level at elevation 224.15 m and backfilled with a minimum 0.4 m thickness of Class 350 riprap to approximately el 224.55.
- Footpath is set at El 228.5 m (22.1 ft JAPSD) with 3.5 m paved width, 3:1 side slopes down to the top of the culvert and 2:1 side slopes from the top of culvert to channel bottom.
- Rock aprons will be required at the culvert ends, which should be armoured with Class 350 Riprap placed 0.55 m thick placed over non-woven geotextile. Rock aprons to extend a minimum of 3 m from the upstream and downstream ends of the culvert.
- The drain will require excavation local to the crossing to permit the transition from the drain to the culvert aprons. The transition should extend over a minimum length of 5 m from the rock apron.
- Aprons will have a 2.0 m base width set at El 224.55 with 3:1 side slopes.

The backwater model of the Dugald Drain was modified to incorporate the concrete pipe option. The estimated water surface profiles for the Dugald Drain with the concrete pipe option are shown on Figure 3 while Table 3 summarizes the hydraulic assessment. Refer to the detail sketches of the Option 1 structure in Appendix C.

It would be possible to shorten the structure using headwalls/wingwalls with only a minor influence on the hydraulic characteristics of the crossing. An estimate of costs for this alternate to Option 1 could be developed for comparison, however typically the extra cost of the headwall/wingwalls offsets the extra pipe length cost. In this case however, the concrete pipe is large and costly and requires large equipment to place increasing the overall cost of installing the pipe relative to constructing headwall/wingwalls. Alternatives to concrete headwalls could be considered however, including an option for gabion headwalls.

Table 3
Happyland Park Crossing - Dugald Drain
Hydraulic Summary for Option 1 - Large Diameter Concrete Pipe

Probability	Discharge (m^3/s)	Seine River Water Level (m)	Headloss (m)	Clearance to Culvert Soffit * (m)	Culvert Velocities (m/s)
50% Discharge	1.2	224.5 Low Seine River	0.07	1.7 clear	0.85
50% Discharge	1.2	225.4 12ft JAPSD	<0.05	1.45 clear	0.55
50% Discharge	1.2	227.2 18ft JAPSD	<0.05	0.3 submerged	0.2
50% Discharge	1.2	229.4 FPL	<0.05	0.9 OT **	0.05
1% Discharge	6.2	225.4 12ft JAPSD	0.25	0.95 clear	2.1
1% Discharge	6.2	227.2 18ft JAPSD	0.08	0.4 submerged	1.15
1% Discharge	6.2	229.4 FPL	<0.05	0.9 OT **	0.15
25 Year + 5 Year Rainfall (Peak)	5.4	225.4 12ft JAPSD	0.21	1.0 clear	1.9
25 Year + 5 Year Rainfall (Peak)	5.4	227.2 18ft JAPSD	<0.05	0.35 submerged	1.0
25 Year + 5 Year Rainfall (Peak)	5.4	229.4 FPL	<0.05	0.9 OT **	0.15
3DQ10	2.2	225.4 12ft JAPSD	0.09	1.4 clear	1.0
3DQ10	2.2	227.2 18ft JAPSD	<0.05	0.3 submerged	0.4
3DQ10	2.2	229.4 FPL	<0.05	0.9 OT **	0.1

* - culvert soffit at approximately el 226.89 m

** - crossing overtopped

You will note that the headloss and culvert velocities are highly dependent on downstream conditions on the Seine River. As indicated, elevated levels on the Seine River due to high flows on the river itself or due to high Red River levels, backwater the Dugald Drain and the crossing. It would be expected that high levels would exist within the Seine River in the event of extreme flows within the Dugald Drain, thereby tempering velocities within the culvert. Flood flows with a more frequent occurrence, such as a 50% flow, could occur under conditions where the Seine River is not elevated, however velocities and headlosses under those conditions are within an acceptable range.

Option 2 – Box Culvert

The proposed option 2 replacement structure for this site is as follows:

- Single 2.44 m wide by 2.44 m high by 11 m long reinforced concrete box culvert with headwalls/wingwalls. Culvert set with 20 degree skew to pathway centreline.
- Culvert invert set level at elevation 224.25 m and backfilled with 0.3 m thickness of Class 350 riprap to approximately el 224.55.
- Footpath is set at El 228.5 m (22.1 ft JAPSD) with 3.5 m paved width, 3:1 side slopes down to the top of the culvert/headwall.
- Rock aprons will be required at the culvert ends, which should be armoured with Class 350 Riprap placed 0.55 m thick placed over non-woven geotextile. Rock aprons to extend a minimum of 3 m from the upstream and downstream ends of the culvert. Aprons will have a 2.4 m base width set at El 224.55.
- The drain will require excavation local to the crossing to permit the transition from the drain to the culvert aprons. The transition should extend over a minimum length of 5 m from the rock apron.

The backwater model of the Dugald Drain was modified to incorporate the box culvert option. The estimated water surface profiles for the Dugald Drain with the box culvert option are shown on Figure 4 while Table 4 summarizes the hydraulic assessment. Refer to the detail sketches of the Option 2 structure in Appendix C.

You will note that the headloss and culvert velocities are highly dependent on downstream conditions on the Seine River. As indicated, elevated levels on the Seine River due to high flows on the river itself or due to high Red River levels, backwater the Dugald Drain and the crossing. It would be expected that high levels would exist within the Seine River in the event of extreme flows within the Dugald Drain, thereby tempering velocities within the culvert. Flood flows with a more frequent occurrence, such as a 50% flow, could occur under conditions where the Seine River is not elevated, however velocities and headlosses under those conditions are within an acceptable range.

Table 4
Happyland Park Crossing - Dugald Drain
Hydraulic Summary for Option 2 - Box Culvert

Probability	Discharge (m^3/s)	Seine River Water Level (m)	Headloss (m)	Clearance to Culvert Soffit * (m)	Culvert Velocities (m/s)
50% Discharge	1.2	224.5 Low Seine River	0.07	1.45 clear	0.75
50% Discharge	1.2	225.4 12ft JAPSD	<0.05	1.25 clear	0.55
50% Discharge	1.2	227.2 18ft JAPSD	<0.05	0.5 submerged	0.25
50% Discharge	1.2	229.4 FPL	<0.05	0.9 OT **	0.1
1% Discharge	6.2	225.4 12ft JAPSD	0.25	0.75 clear	2.15
1% Discharge	6.2	227.2 18ft JAPSD	0.08	0.55 submerged	1.2
1% Discharge	6.2	229.4 FPL	<0.05	0.9 OT **	0.2
25 Year + 5 Year Rainfall (Peak)	5.4	225.4 12ft JAPSD	0.21	0.85 clear	1.95
25 Year + 5 Year Rainfall (Peak)	5.4	227.2 18ft JAPSD	<0.05	0.55 submerged	1.05
25 Year + 5 Year Rainfall (Peak)	5.4	229.4 FPL	<0.05	0.9 OT **	0.2
3DQ10	2.2	225.4 12ft JAPSD	0.09	1.15 clear	1.0
3DQ10	2.2	227.2 18ft JAPSD	<0.05	0.5 submerged	0.4
3DQ10	2.2	229.4 FPL	<0.05	0.9 OT **	0.1

* - culvert soffit at approximately el 226.69 m

** - crossing overtopped

Option 3 – Clear Span Bridge

The option 3 replacement structure for this site is as follows:

- 16 m long - 4 m wide clear span footbridge.
- Bridge deck set at El 228.5 m (22.1 ft JAPSD). Underside of girder is approximately 227.9 depending on the depth of bridge girders and deck.
- Excavate the bridge opening with a 1 m base set at El 224.6 and 3:1 headslopes. Place rock armouring within the entire bridge opening and along the abutment faces. The rock armouring should extend 3 m upstream and downstream of the outside faces of the bridge structure, wrapping around the abutment and extending up to approximately el 228.0. The rock armouring would consist of a 0.55 m thickness of Class 350 rock placed over non-woven geotextile.

The backwater model of the Dugald Drain was modified to incorporate the clear span bridge option. The estimated water surface profiles for the Dugald Drain with the bridge option are shown on Figure 5 while Table 5 summarizes the hydraulic assessment. Refer to the detail sketches of the Option 3 structure in Appendix C.

Table 5
Happyland Park Crossing - Dugald Drain
Hydraulic Summary for Option 3 - Clear Span Bridge

Probability	Discharge (m^3/s)	Seine River Water Level (m)	Headloss (m)	Clearance to Underside of Girder * (m)	Bridge Opening Velocities (m/s)
50% Discharge	1.2	224.5 Low Seine River	<0.05	2.6 clear	0.6
50% Discharge	1.2	225.4 12ft JAPSD	<0.05	2.45 clear	0.4
50% Discharge	1.2	227.2 18ft JAPSD	<0.05	0.7 clear	0.05
50% Discharge	1.2	229.4 FPL	<0.05	0.9 OT **	0.02
1% Discharge	6.2	225.4 12ft JAPSD	<0.05	2.0 clear	1.0
1% Discharge	6.2	227.2 18ft JAPSD	<0.05	0.7 clear	0.25
1% Discharge	6.2	229.4 FPL	<0.05	0.9 OT **	0.1
25 Year + 5 Year Rainfall (Peak)	5.4	225.4 12ft JAPSD	<0.05	2.1 clear	1.0
25 Year + 5 Year Rainfall (Peak)	5.4	227.2 18ft JAPSD	<0.05	0.7 clear	0.25
25 Year + 5 Year Rainfall (Peak)	5.4	229.4 FPL	<0.05	0.9 OT **	0.1
3DQ10	2.2	225.4 12ft JAPSD	<0.05	2.35 clear	0.65
3DQ10	2.2	227.2 18ft JAPSD	<0.05	0.7 clear	0.1
3DQ10	2.2	229.4 FPL	<0.05	0.9 OT **	0.05

* - underside of girder at approximately el 227.9 m

** - crossing overtopped

Option 4 – Double Concrete Pipes

The proposed option 41 replacement structure for this site is as follows:

- Double 1.83 m diameter by 23.5 m long precast concrete pipes without headwalls (projecting from fill). Culvert set with 22 degree skew to pathway centreline.
- Culvert invert set level at elevation 224.3 m and backfilled with 0.3 m thickness of Class 350 riprap to approximately el 224.6.
- Footpath is set at El 228.5 m (22.1 ft JAPSD) with 3.5 m paved width, 3:1 side slopes down to the top of the culvert and 2:1 side slopes from the top of culvert to channel bottom.
- Rock aprons will be required at the culvert ends, which should be armoured with Class 350 Riprap placed 0.55 m thick placed over non-woven geotextile. Rock aprons to extend a minimum of 3 m from the upstream and downstream ends of the culvert.
- The drain will require excavation local to the crossing to permit the transition from the drain to the culvert aprons. The transition should extend over a minimum length of 5 m from the rock apron.
- Aprons will have a 5.0 m base width set at El 224.6 with 3:1 side slopes.

The backwater model of the Dugald Drain was modified to incorporate the double concrete pipe option. The estimated water surface profiles for the Dugald Drain with the double concrete pipe option are shown on Figure 6 while Table 6 summarizes the hydraulic assessment. Refer to the detail sketches of the Option 4 structure in Appendix C.

It would be possible to shorten the structure using headwalls/wingwalls with only a minor influence on the hydraulic characteristics of the crossing. An estimate of costs for this alternate to Option 4 could be developed for comparison, however typically the extra cost of the headwall/wingwalls offsets the extra pipe length cost. Alternatives to concrete headwalls could be considered however, including an option for gabion headwalls.

You will note that the headloss and culvert velocities are highly dependent on downstream conditions on the Seine River. As indicated, elevated levels on the Seine River due to high flows on the river itself or due to high Red River levels, backwater the Dugald Drain and the crossing. It would be expected that high levels would exist within the Seine River in the event of extreme flows within the Dugald Drain, thereby tempering velocities within the culvert. Flood flows with a more frequent occurrence, such as a 50% flow, could occur under conditions where the Seine River is not elevated, however velocities and headlosses under those conditions are within an acceptable range.

Table 6
Happyland Park Crossing - Dugald Drain
Hydraulic Summary for Option 4 - Double Concrete Pipes

Probability	Discharge (m^3/s)	Seine River Water Level (m)	Headloss (m)	Clearance to Culvert Soffit * (m)	Culvert Velocities (m/s)
50% Discharge	1.2	224.5 Low Seine River	<0.05	0.95 clear	0.65
50% Discharge	1.2	225.4 12ft JAPSD	<0.05	0.7 clear	0.45
50% Discharge	1.2	227.2 18ft JAPSD	<0.05	1.1 submerged	0.25
50% Discharge	1.2	229.4 FPL	<0.05	0.9 OT **	0.05
1% Discharge	6.2	225.4 12ft JAPSD	0.20	0.2 clear	1.6
1% Discharge	6.2	227.2 18ft JAPSD	0.14	1.2 submerged	1.3
1% Discharge	6.2	229.4 FPL	<0.05	0.9 OT **	0.15
25 Year + 5 Year Rainfall (Peak)	5.4	225.4 12ft JAPSD	0.14	0.3 clear	1.45
25 Year + 5 Year Rainfall (Peak)	5.4	227.2 18ft JAPSD	0.10	1.2 submerged	1.15
25 Year + 5 Year Rainfall (Peak)	5.4	229.4 FPL	<0.05	0.9 OT **	0.15
3DQ10	2.2	225.4 12ft JAPSD	<0.05	0.6 clear	0.75
3DQ10	2.2	227.2 18ft JAPSD	<0.05	1.1 submerged	0.5
3DQ10	2.2	229.4 FPL	<0.05	0.9 OT **	0.1

* - culvert soffit at approximately el 226.13 m

** - crossing overtopped

The only other concern related to this option would be the soffit submergence under conditions where the Seine River is elevated by high Red River levels. Elevated Seine River levels and the associated backwater influence at the crossing are fairly common and will occur frequently as noted in recent years. As indicated in the design requirements, it is typically preferred to have the soffit clear of the design water surface profile to minimize blockage by debris. Although large trees exist adjacent to the drain, the number is limited reducing the overall risk of blockage. Additionally, the installation with double pipes reduces the potential for complete blockage.

5 Other Considerations

Best Management Practices for working near waterways including the appropriate implementation of sediment and erosion control measures should be followed. Exposed slopes not covered with rock should be revegetated and covered with erosion control blanket. Construction activities within the drain shall not take place between April 1 and June 15 of any given year. An Environmental Management Plan should be prepared which details the specific environmental management requirements and sediment and erosion control.

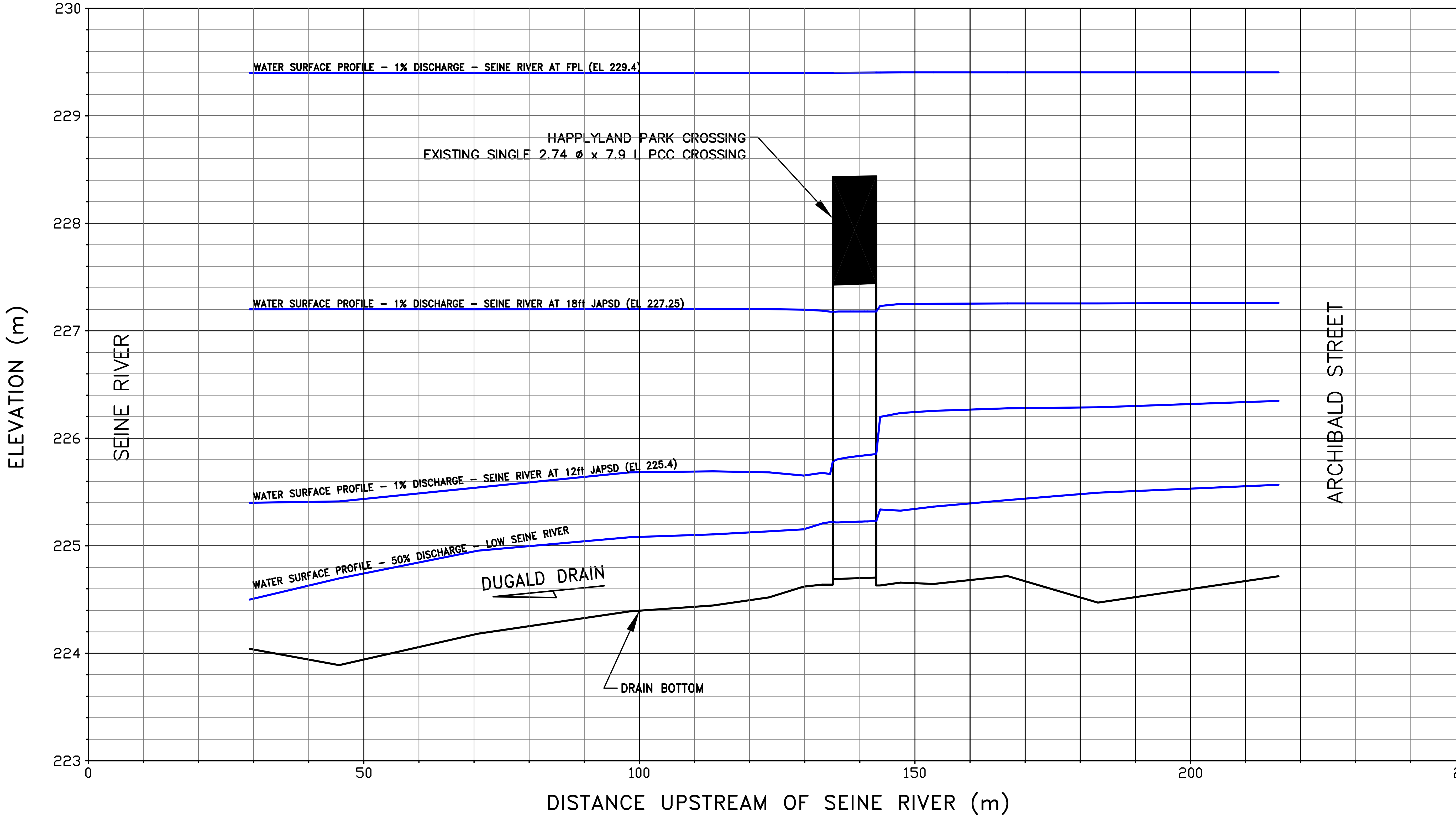
Water management during construction can be an important aspect of any project and may influence the cost and scheduling for crossing replacement. The largest flows within the drain are expected to occur during the spring runoff period and following a heavy summer rainfall event. Construction should take place in the late fall and winter period when the potential for runoff is reduced thereby minimizing water management requirements. Although minimal, flows continue throughout the winter, and should be considered as part of the water management plan with appropriate measures taken to deal with the flow.

Disruption, destruction or loss of aquatic habitat may occur depending on the replacement crossing option selected. The bridge option could possibly be considered under the Fisheries and Oceans “Clear Span Bridge” *Operational Statement*; as the opening will be much larger than what presently exists and would result in a net gain in habitat. Both culvert options however would result in the infilling of the drain and loss of habitat. The use of rockfill on the invert of the culvert will help to offset the loss, however the shorter box culvert option (or possibly concrete pipe with headwalls) would help to minimize the footprint and overall disruption. Habitat compensation for the culvert options may be required, but could possibly be mitigated with spawning shoals or tree plantings within the drain.

Figures

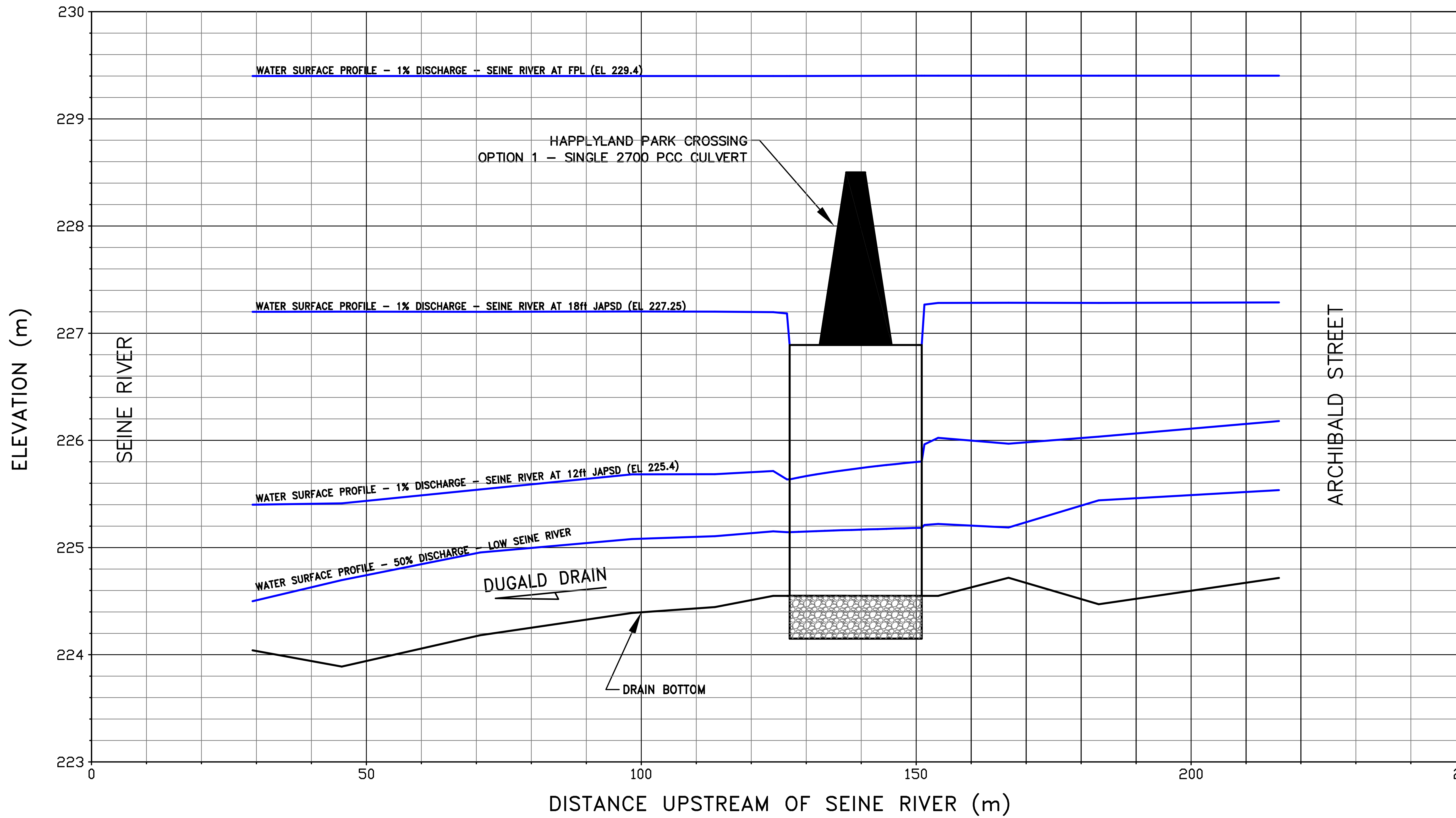
HAPPYLAND PARK – DUGALD DRAIN CROSSING
LOCATION PLAN
FIGURE 1

SCALE 1:2500 (METRES)
50 0 50 100



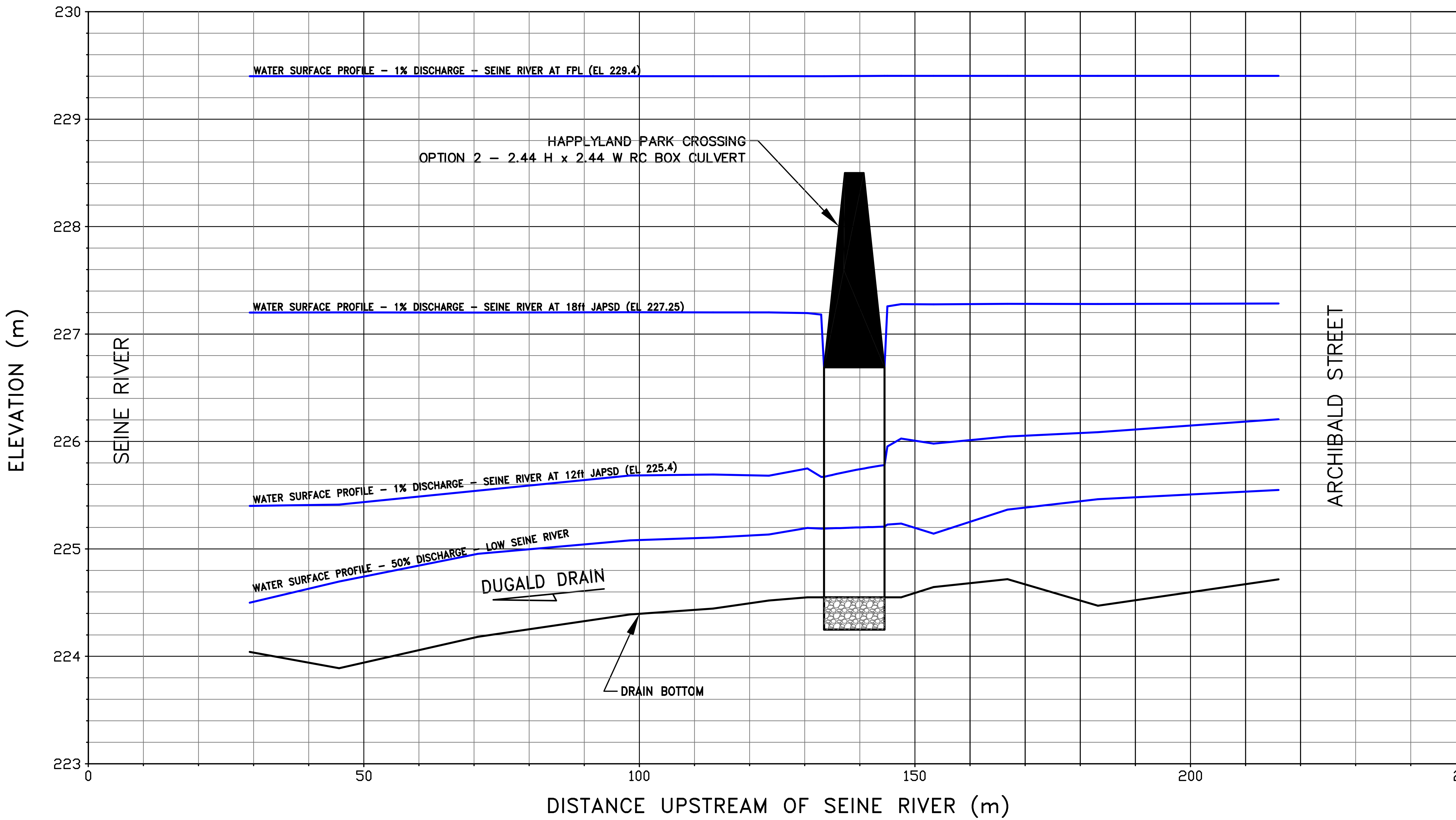
HAPPYLAND PARK – DUGALD DRAIN CROSSING
WATER SURFACE PROFILES
EXISTING CONDITIONS
FIGURE 2

NOTES:
1) HEC-RAS MODEL DEVELOPED FROM OCTOBER 2013 SURVEY DATA
2) WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH EXISTING SINGLE 2.74mø PRECAST CONCRETE PIPE CULVERT CROSSING



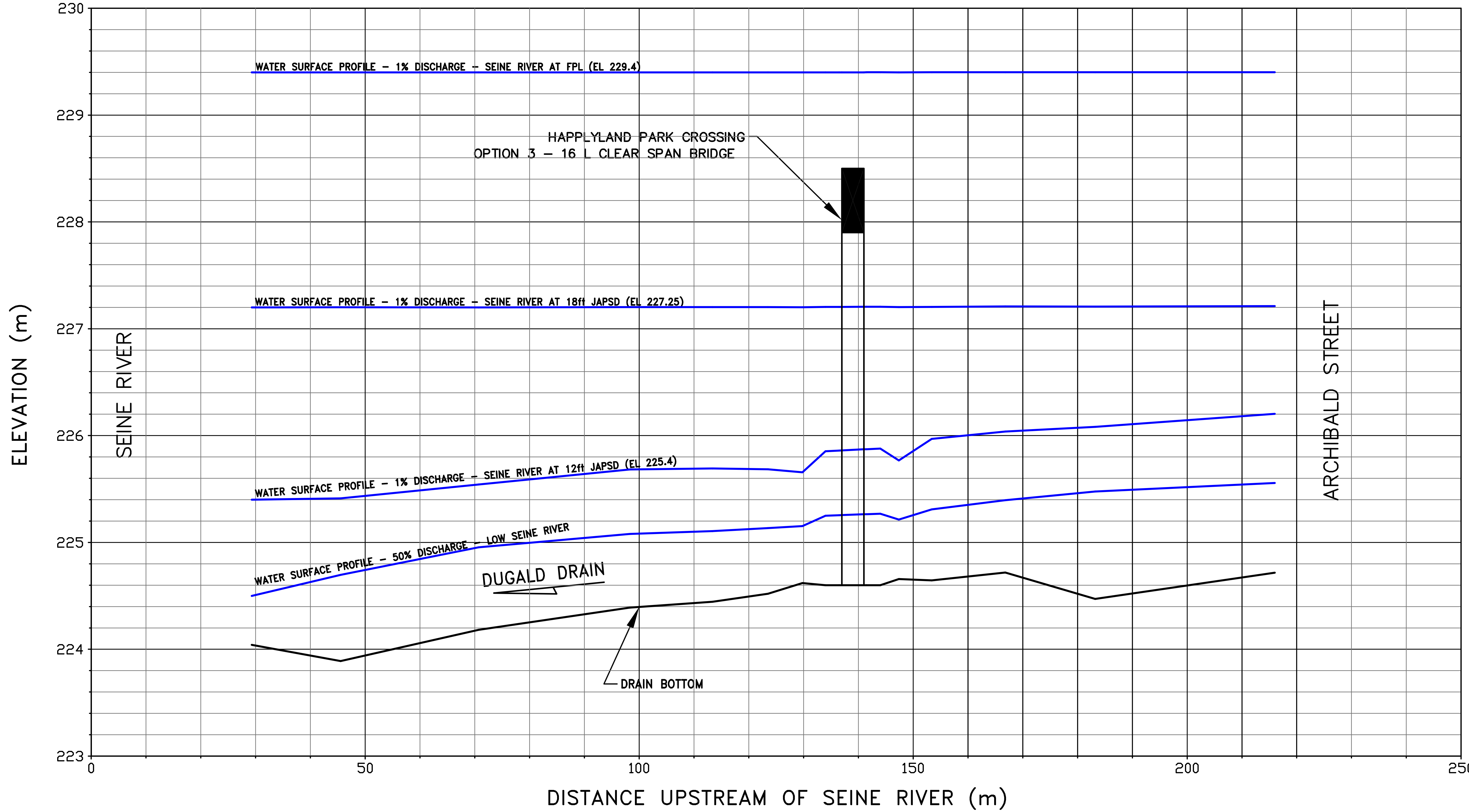
NOTES:
1) HEC–RAS MODEL DEVELOPED FROM OCTOBER 2013 SURVEY DATA
2) WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH OPTION 1 – SINGLE 2.74ø x 23 L PRECAST CONCRETE PIPE CULVERT CROSSING

HAPPYLAND PARK – DUGALD DRAIN CROSSING
WATER SURFACE PROFILES
OPTION 1 – LARGE DIAMETER CONCRETE PIPE
FIGURE 3



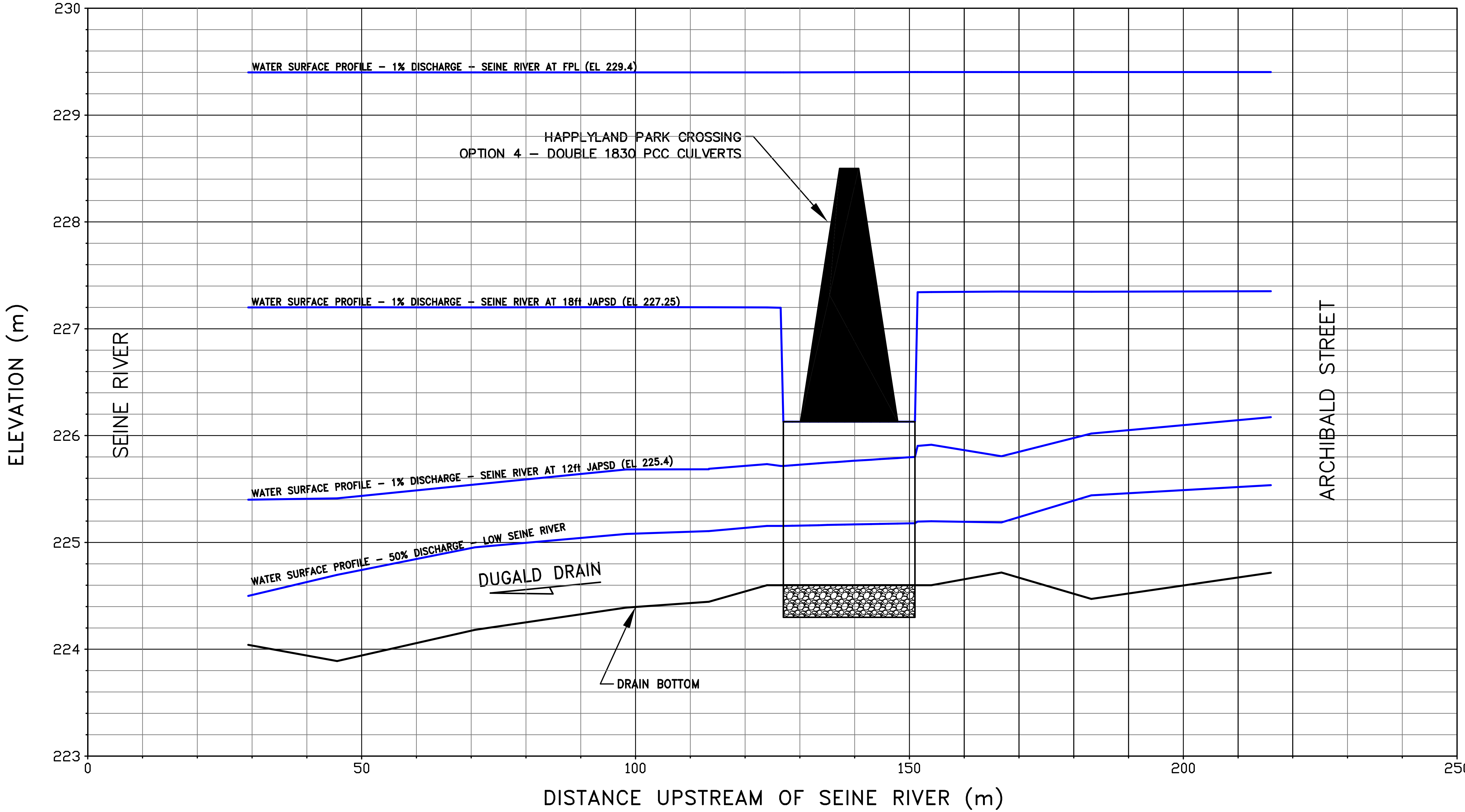
HAPPYLAND PARK - DUGALD DRAIN CROSSING
WATER SURFACE PROFILES
OPTION 2 - RC BOX CULVERT
FIGURE 4

NOTES:
1) HEC-RAS MODEL DEVELOPED FROM OCTOBER 2013 SURVEY DATA
2) WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH
OPTION 2 - SINGLE 2.44 H x 2.44 W X 11 L REINFORCED CONCRETE BOX CULVERT



HAPPYLAND PARK – DUGALD DRAIN CROSSING
WATER SURFACE PROFILES
OPTION 3 – CLEAR SPAN BRIDGE
FIGURE 5

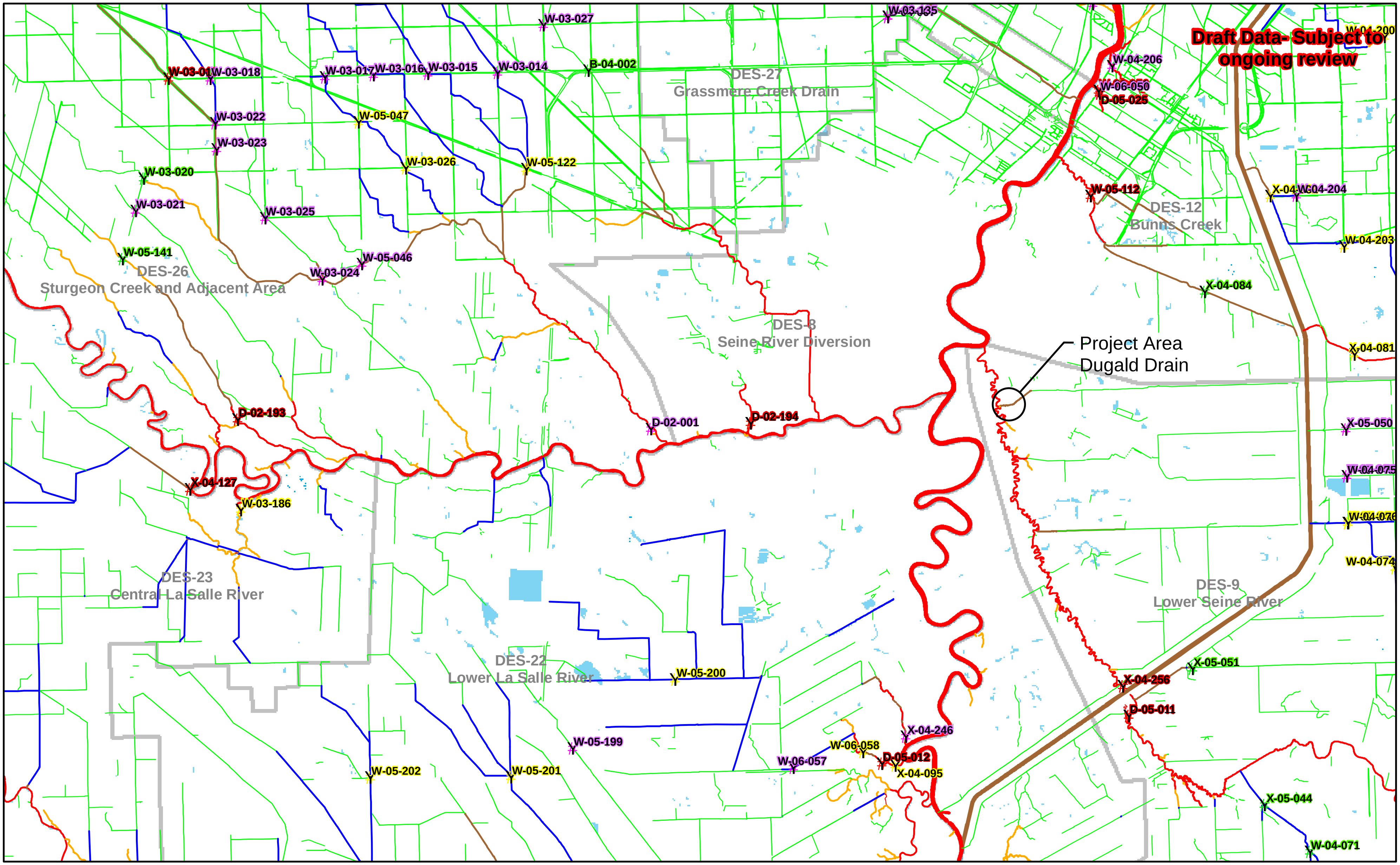
NOTES:
1) HEC-RAS MODEL DEVELOPED FROM OCTOBER 2013 SURVEY DATA
2) WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH OPTION 3 – 16 m L CLEAR SPAN BRIDGE



HAPPYLAND PARK – DUGALD DRAIN CROSSING
WATER SURFACE PROFILES
OPTION 4 – CONCRETE PIPES
FIGURE 6

NOTES:
1) HEC-RAS MODEL DEVELOPED FROM OCTOBER 2013 SURVEY DATA
2) WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH OPTION 4 – DOUBLE 1.83ø x 23.5 L PRECAST CONCRETE PIPE CULVERT CROSSING

Appendix A
Fish Habitat Classification Map



062I04	062I03	062I02
062H13	062H14	062H15
062H12	062H11	062H10

Habitat Classification

- A
- B
- C
- D
- E

Fishing Results

- Indicator Species
- Non-Indicator Species
- No Catch
- No Fishing Effort

Appendix 9

Sampling sites, fish captures and habitat classification of streams and constructed drains throughout agricultural areas of Manitoba (2002 – 2006)

062H14

Produced April 2012

Appendix B
Photographs

Happyland Park Crossing - Dugald Drain – Crossing Replacement

Photo No. 1 Dugald Drain upstream of Happyland Park Crossing

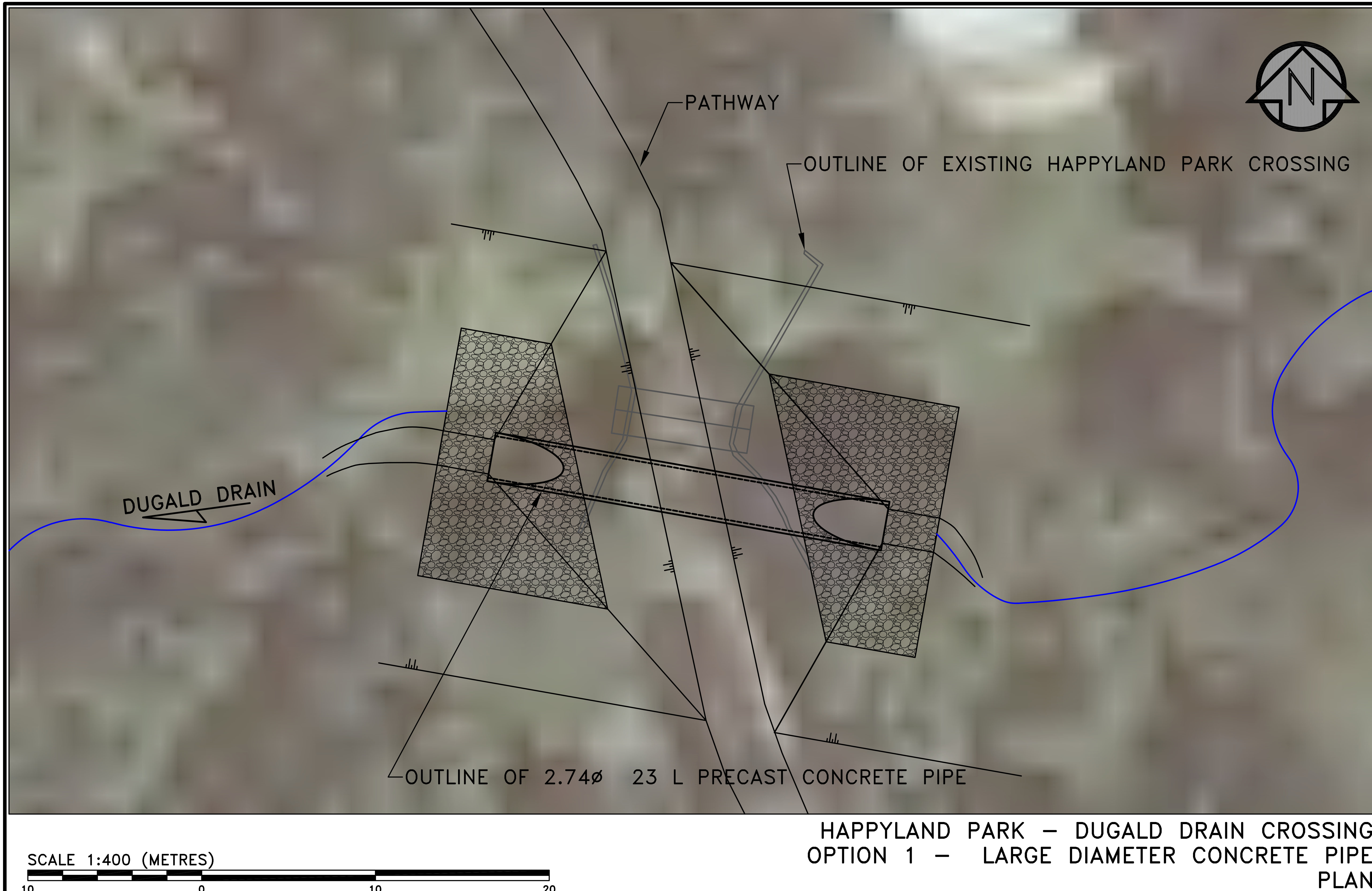
Photo No. 2 Upstream side of Happyland Park Crossing

Note all photos taken October 4, 2013

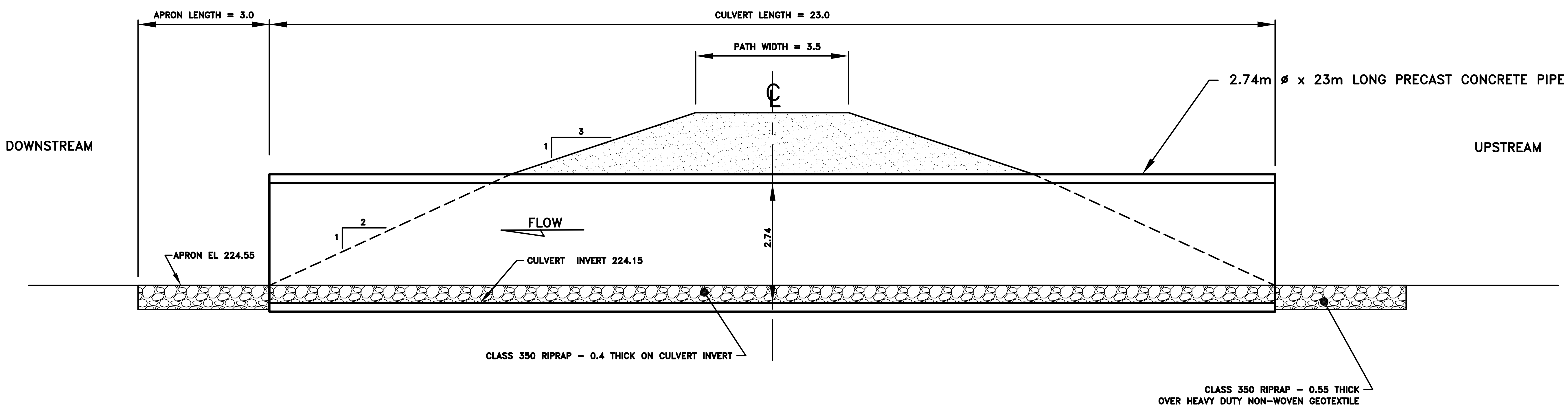
Photo No. 3 Downstream side of Happyland Park Crossing

Photo No. 4 Dugald Drain downstream of Happyland Park Crossing

Appendix C
Crossing Replacement Option Sketches

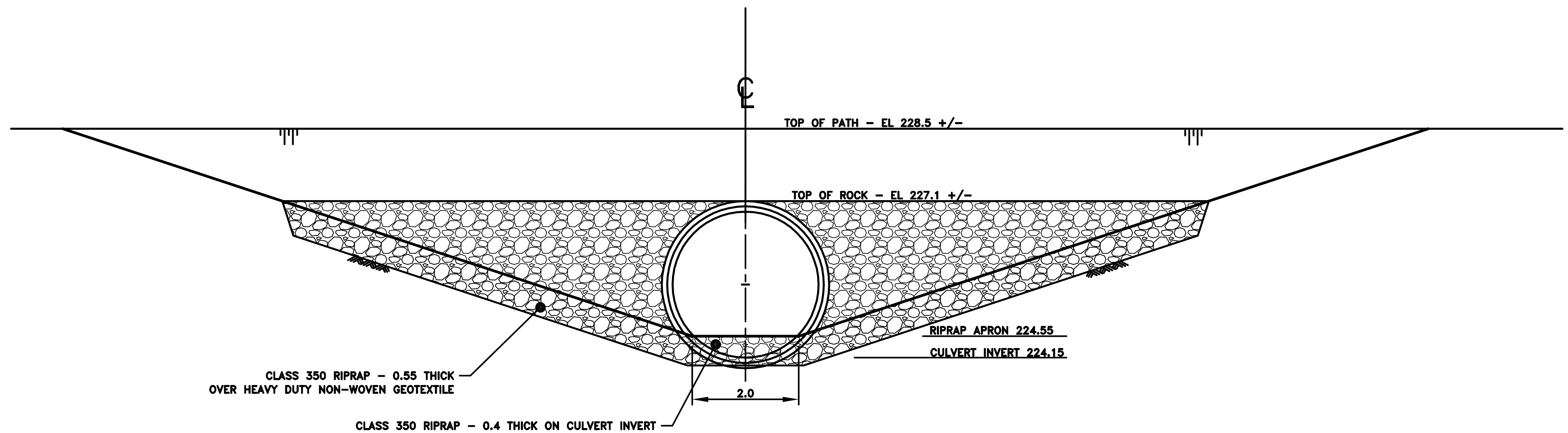


HAPPYLAND PARK – DUGALD DRAIN CROSSING
OPTION 1 – LARGE DIAMETER CONCRETE PIPE
PLAN



PROFILE – ALONG CENTRELINE OF CULVERT

SCALE: 1:200



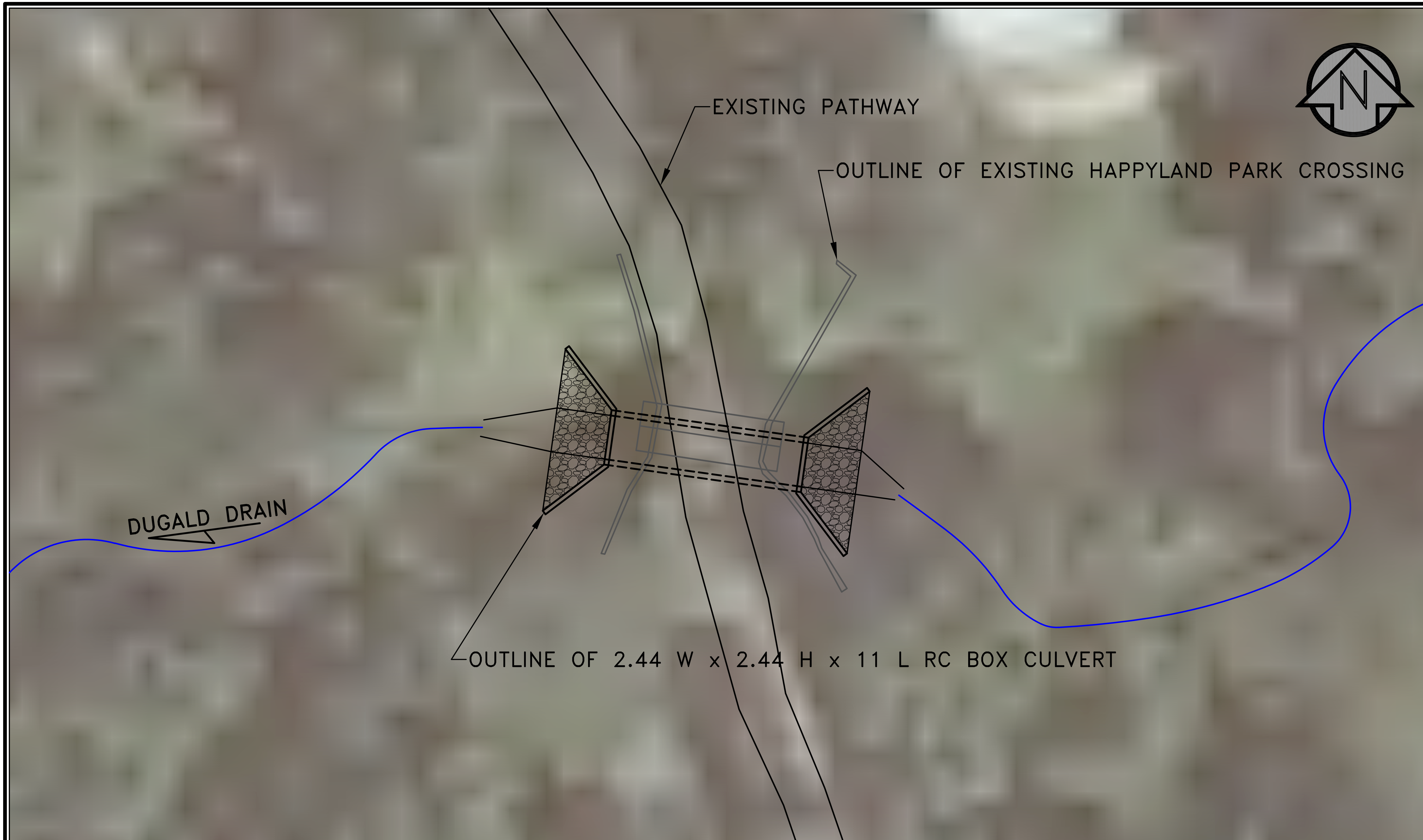
SECTION UPSTREAM OF CROSSING

SCALE: 1:200

SCALE 1:200 (METRES)

5 0 5 10

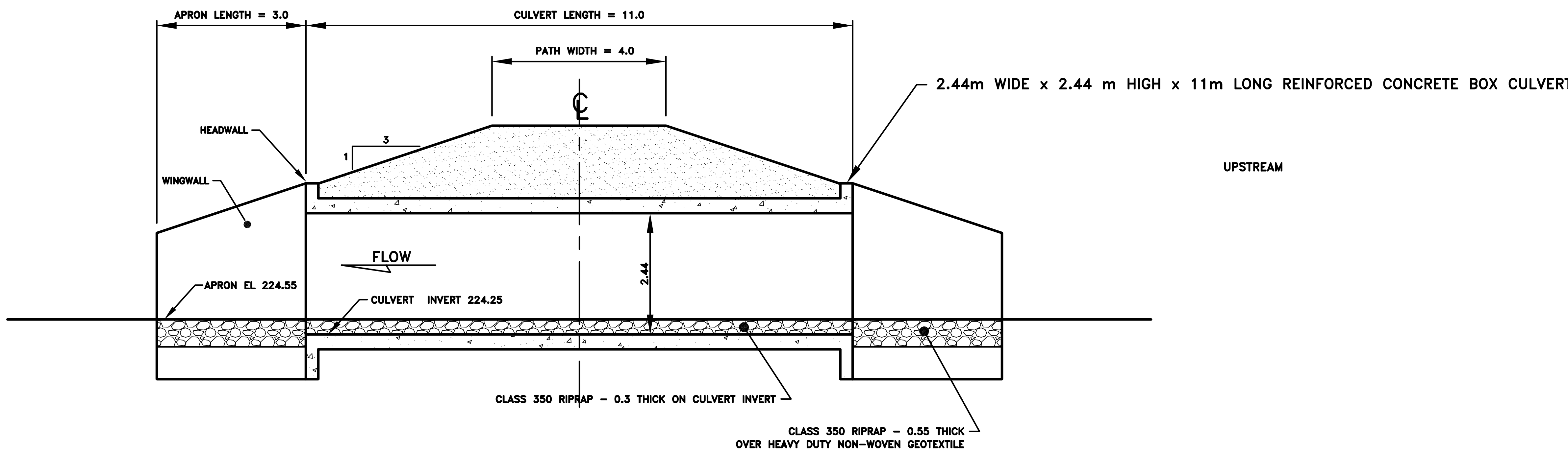
HAPPYLAND PARK – DUGALD DRAIN CROSSING
OPTION 1 – LARGE DIAMETER CONCRETE PIPE
SECTIONS AND DETAILS



SCALE 1:400 (METRES)

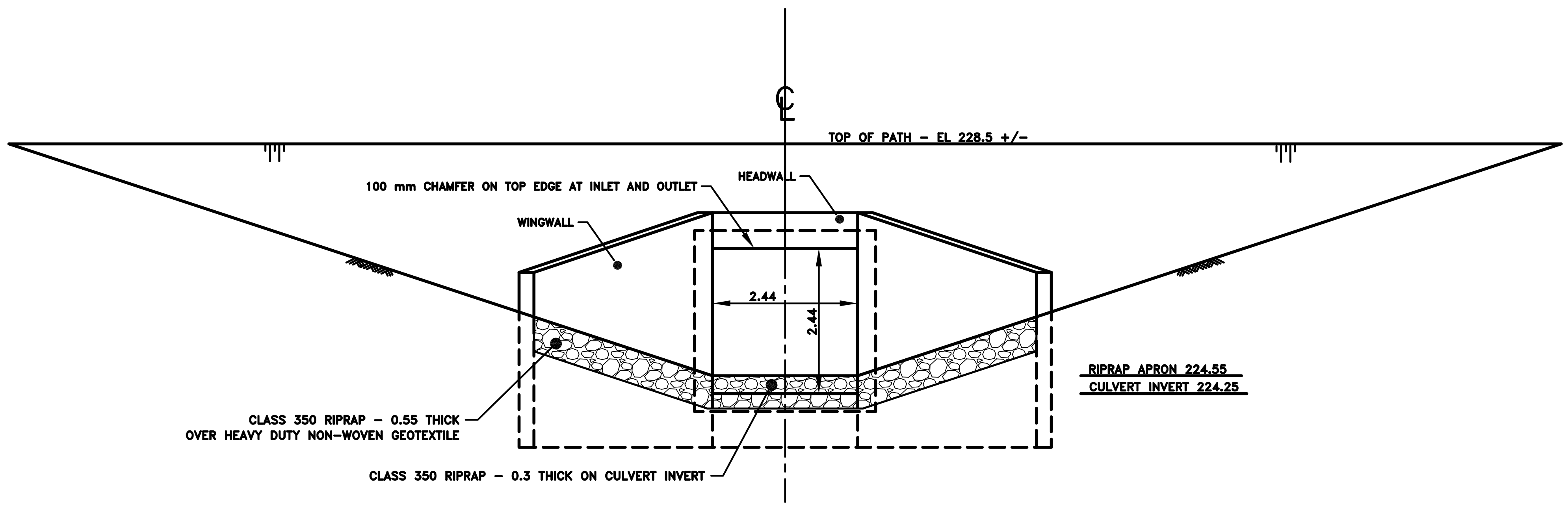
10 0 10 20

HAPPYLAND PARK – DUGALD DRAIN CROSSING
OPTION 2 – REINFORCED CONCRETE BOX CULVERT
PLAN



PROFILE – ALONG CENTRELINE OF CULVERT

SCALE: 1:200



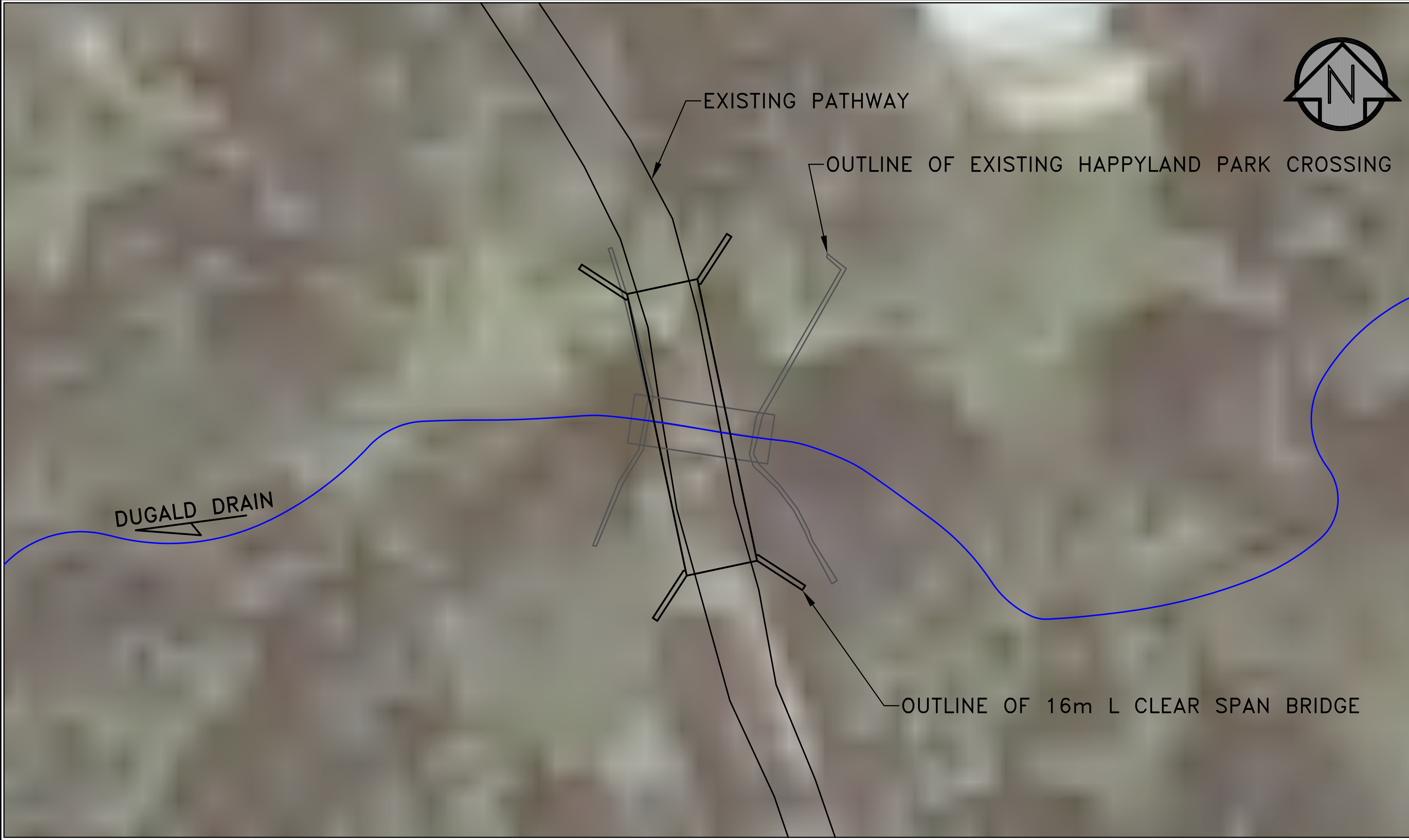
SECTION UPSTREAM OF CROSSING

SCALE: 1:200

SCALE 1:200 (METRES)

5 0 5 10

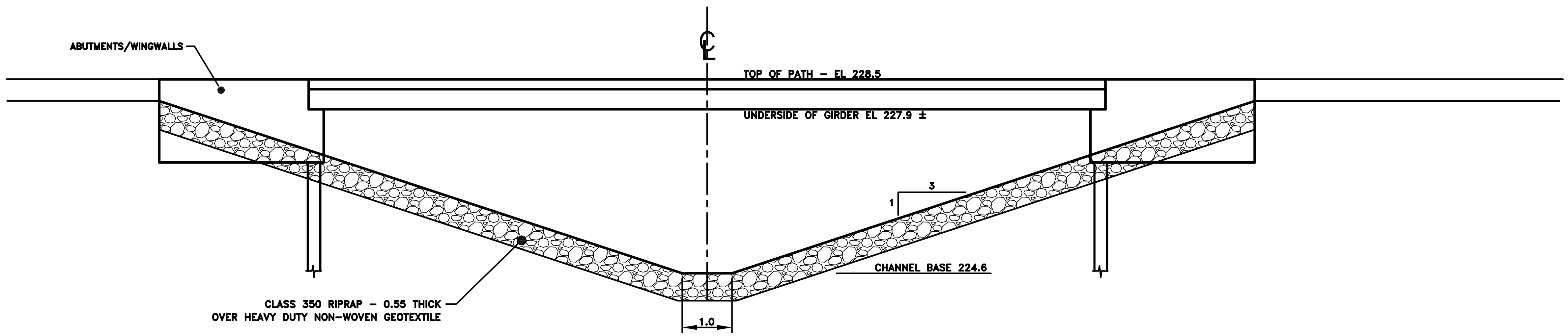
HAPPYLAND PARK – DUGALD DRAIN CROSSING
OPTION 2 – REINFORCED CONCRETE BOX CULVERT
SECTIONS AND DETAILS



SCALE 1:400 (METRES)

10 0 10 20

HAPPYLAND PARK – DUGALD DRAIN CROSSING
OPTION 3 – CLEAR SPAN BRIDGE
PLAN



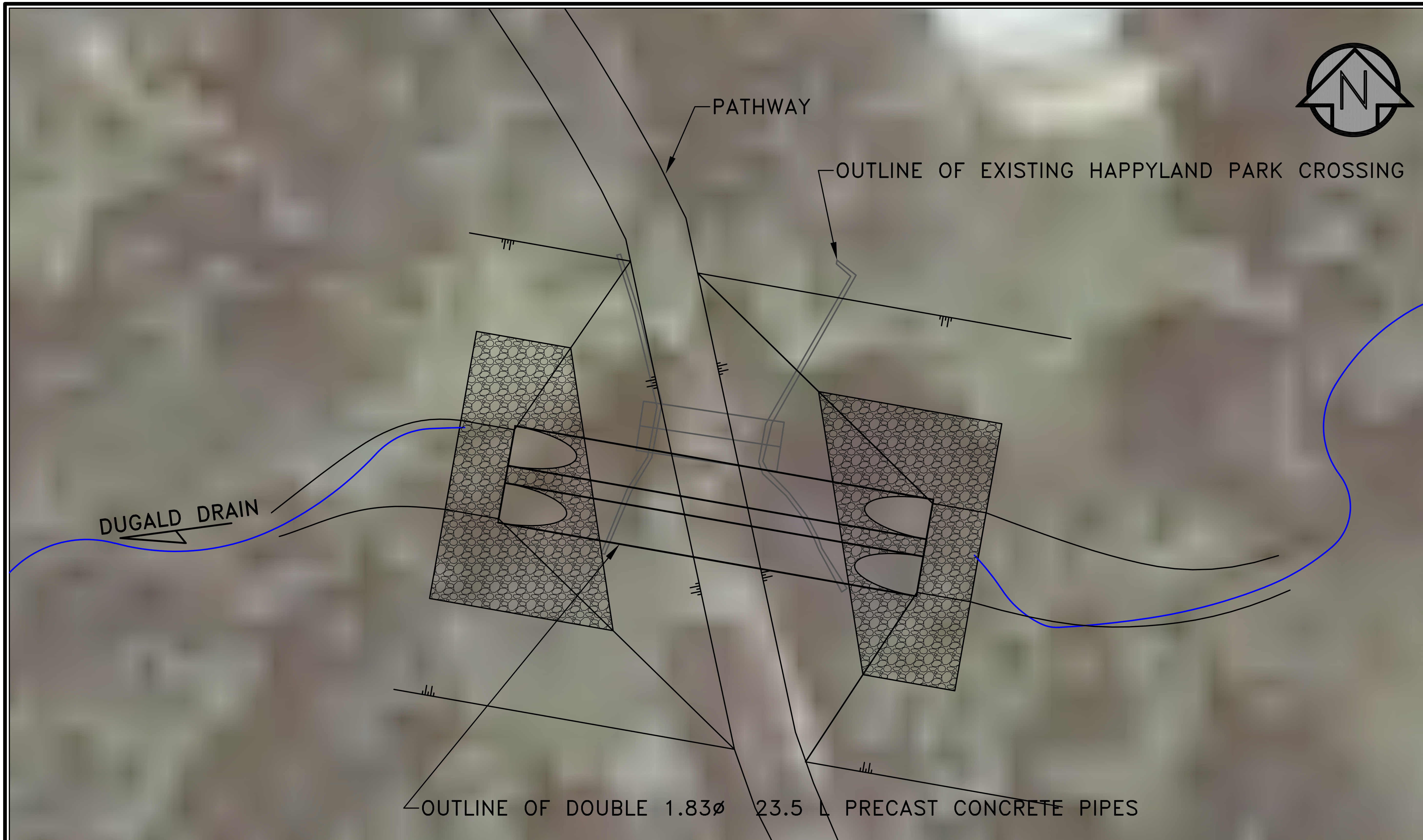
SECTION UPSTREAM OF CROSSING

SCALE: 1:200

SCALE 1:200 (METRES)

5 0 5 10

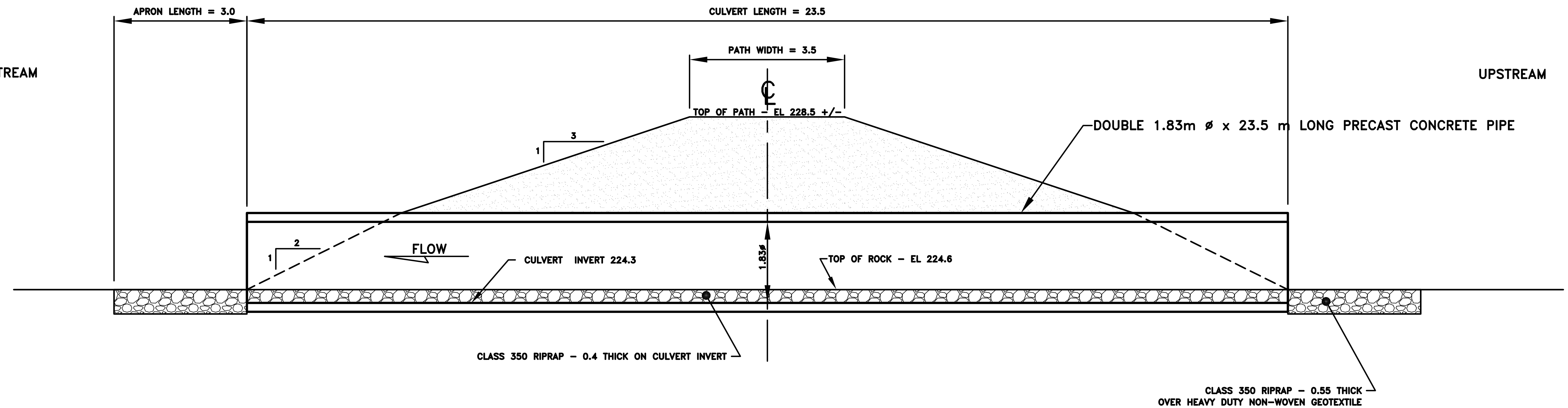
HAPPYLAND PARK – DUGALD DRAIN CROSSING
OPTION 3 – CLEAR SPAN BRIDGE
SECTIONS AND DETAILS



SCALE 1:400 (METRES)

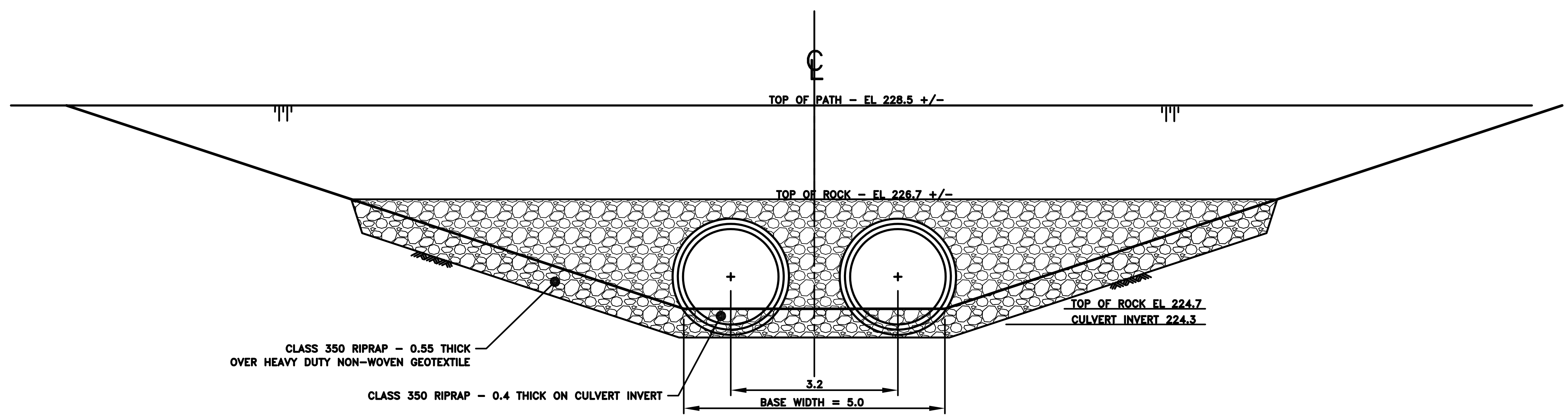
10 0 10 20

HAPPYLAND PARK – DUGALD DRAIN CROSSING
OPTION 4 – CONCRETE PIPES
PLAN



PROFILE – ALONG CENTRELINE OF CULVERT

SCALE: 1:200



SECTION UPSTREAM OF CROSSING

SCALE: 1:200

SCALE 1:200 (METRES)

5 0 5 10

HAPPYLAND PARK – DUGALD DRAIN CROSSING
OPTION 4 – CONCRETE PIPES
SECTIONS AND DETAILS