ANEJO Nº 8

DRENAJE

ÍNDICE

1. INTRODUCCIÓN 3

2. ESTUDIO DE CUENCAS INTERNAS AL CENTRO TECNOLÓGICO NOKIAN TYRES 3

3. OBTENCIÓN DE LOS CAUDALES PARA DIFERENTES ELEMENTOS DE DRENAJE DEL ÁREA DE PROYECTO 6

4. DIMENSIONAMIENTO DEL DRENAJE LONGITUDINAL Y TRANSVERSAL 6

4.1. DRENAJE TRANSVERSAL 6
4.1.1. Planteamiento General 6
4.1.2. Elementos de drenaje transversal 6
4.1.3. Características de las ODTs 7
4.2. DRENAJE LONGITUDINAL 12
4.2.1. Planteamiento General 12
4.2.2. Elementos del drenaje longitudinal 12
4.3. OTROS ELEMENTOS DE DRENAJE 15
4.3.1. Bajantes 15
4.3.2. Colectores 16
4.3.3. Pasos salvacuneta 16
4.3.4. Arquetas y arquetas sumidero 16
4.3.5. Dren colector 16

APÉNDICE 1.- RESULTADO CÁLCULOS ODT HIGHSPEEDOVAL HY-8

APÉNDICE 2.- RESULTADO CÁLCULOS CIRCUITOS INTERNOS HY-8

APÉNDICE 3.- RESULTADO CÁLCULOS CUNETAS

ANEJO Nº8

DRENAJE

1. INTRODUCCIÓN

El objeto del presente anejo es detallar el sistema de drenaje de las instalaciones del Centro Tecnológico Nokian Tyres (CTNT). A lo largo del documento se presenta el estudio de los diferentes elementos de evacuación de agua de escorrentía superficial que afectan al trazado, tanto por la intersección con cauces naturales como por la nueva escorrentía generada en los diferentes circuitos y edificios del CTNT.

La información obtenida en el Anejo 4 de Climatología e Hidrología es utilizada para abordar los cálculos más detallados de los diferentes elementos presentes en este anejo.

Por la configuración de los distintos elementos que forman el Centro Tecnológico (explanadas para las distintas instalaciones y viales), la mayor parte serán elementos de drenaje longitudinal, formado por una red de cunetas interiores que evacúen el agua de lluvia de las plataformas, y una red de cunetas exteriores a las plataformas. Finalmente, se propone la construcción de un canal de descarga para poder drenar la zona deprimida dentro de la parcela del circuito. Con ello se pretende canalizar el agua de lluvia para evitar que se almacene e infiltre. Como elementos de drenaje transversal existen varios tubos pasa cunetas para solucionar los cruces de las cunetas con los viales.

La metodología utilizada para el estudio de drenaje se basa fundamentalmente en la Instrucción 5.2.-I.C.:"Drenaje Superficial". También se han tenido en cuenta las 5.1-IC "Drenaje" y "Obras pequeñas de paso: Dimensionamiento hidráulico" de la Dirección general de Carreteras.

En el anejo 4 de Climatología e Hidrología se caracterizan las principales cuencas que vierten sobre el emplazamiento del CTNT, y es en este anejo donde se estudia más detalladamente la interacción entre las cuencas drenantes y el conjunto de circuitos y edificaciones que componen el CTNT.

El presente Anejo aborda en primer lugar la definición y dimensionamiento hidráulico de las obras de drenaje transversal necesarias para el adecuado funcionamiento de la red hidrológica superficial.

En segundo lugar se estudia y dimensiona la red de drenaje longitudinal, aquella que permita evacuar la escorrentía superficial de la plataforma y de los márgenes que vierten hacia ella, y por otro la red de drenaje subterráneo, bajo la plataforma, que se considera necesaria para evacuar el agua al terreno y evitar daños a la misma.

2. ESTUDIO DE CUENCAS INTERNAS AL CENTRO TECNOLÓGICO NOKIAN TYRES

En el Anejo 4 "Climatología e Hidrología" se exponen, en primer lugar, unas cuencas de estudio obtenidas mediante ráster. Las cuencas obtenidas mediante los procedimientos indicados anteriormente han servido para delimitar las áreas de posible afección (AE1-AE6) de la construcción del circuito a la escorrentía superficial presente en la zona. Partiendo de esta información, se realiza un estudio pormenorizado de las mismas en cuyo resultado se obtienen unas cuencas internas, definidas también en el mismo anejo, que delimitan con mayor exactitud las áreas de depresión o acumulación de escorrentía del terreno natural afectado por la construcción del óvalo exterior del CNTN, donde se sitúan las obras de drenaje transversal propuestas (ODT). La situación de estas cuencas se muestra en la Figura 1. Cuencas interiores al CTNT.

Las cuencas internas al CTNT servirán para calcular el caudal máximo de diseño para las obras de drenaje transversal que afectan tanto al óvalo exterior como a los distintos circuitos interiores. La caracterización física e hidrológica de las cuencas queda definida en el Anejo 4.

A la hora de determinar el diseño de los elementos de desagüe es fundamental estudiar el grado de afección de las mismas sobre el emplazamiento considerado.

En primer lugar se ha realizado la definición y el dimensionamiento hidráulico de las obras de drenaje transversal necesarias para el adecuado funcionamiento de la red hidrológica superficial. En esta fase se engloban tanto las exteriores al circuito como las del interior al mismo. Para la realización de este cálculo se han tenido en cuenta los diferentes terrenos que aportan escorrentía a nuestra cuenca con diferentes coeficientes de escorrentía. En nuestro caso, se utilizan los correspondientes coeficientes de escorrentía calculados para zonas donde hay firme y para el terreno presente dentro de cada cuenca. Este cálculo se realiza según la metodología descrita en el capítulo 11 del Anejo de Climatología e Hidrología que se corresponde a la descrita en la norma 5.2 – IC Drenaje Superficial de la Instrucción de carreteras.

Con ello se obtienen el caudal que se genera por escorrentía superficial en el terreno y el que se genera en la carretera.

En segundo lugar se ha estudiado y dimensionado la red de drenaje longitudinal, consistente en un conjunto de cunetas revestidas de hormigón de diferentes tipologías, localizadas a ambos lados de la carretera que rodean el perímetro del CTNT, permiten evacuar tanto la escorrentía superficial como el agua de la carretera y el que se dirija a los desmontes o terraplenes.

Además, se define unos encauzamientos que conducen el agua que se acumula en la zona deprimida, cuya finalidad es la derivación del agua acumulada en ese punto hacia una de las obras de drenaje transversal.

A continuación se muestra una imagen de las cuencas internas al CTNT, cuyos caudales se han utilizado para el dimensionamiento de los distintos elementos de drenaje considerados.

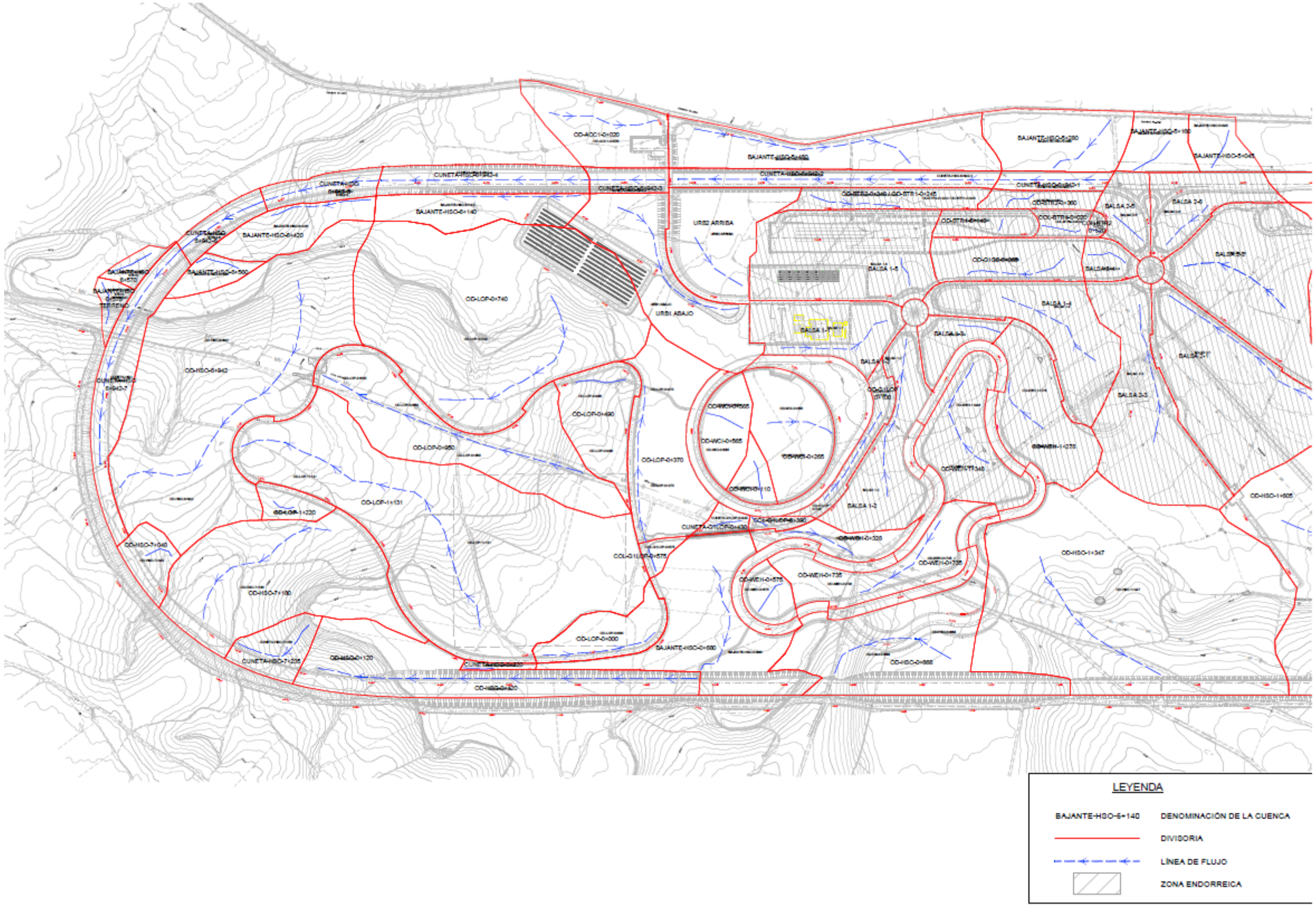


Figura 1. Cuencas internas parte 1

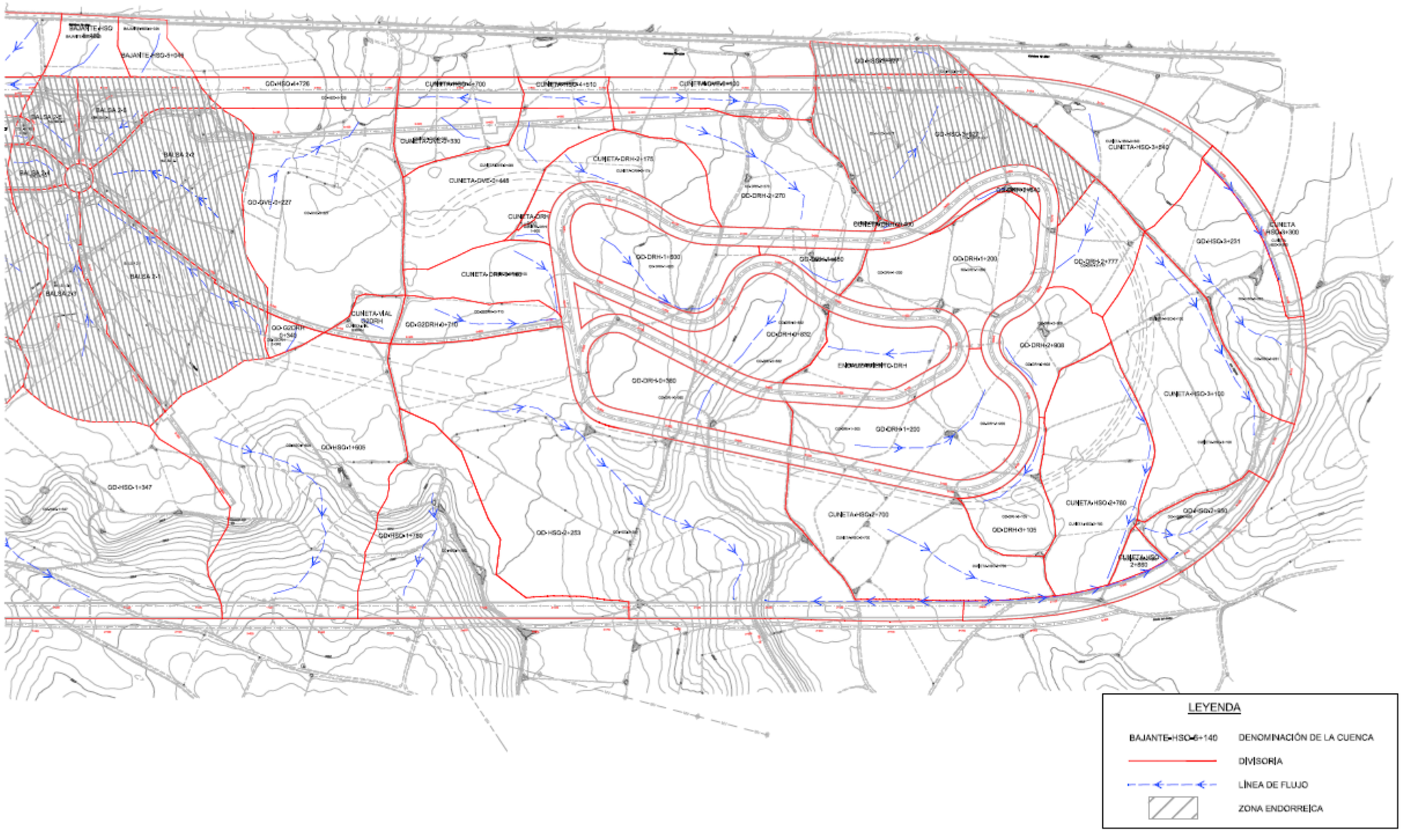


Figura 2. Cuencas internas parte 2

3. OBTENCIÓN DE LOS CAUDALES PARA DIFERENTES ELEMENTOS DE DRENAJE DEL ÁREA DE PROYECTO

En relación a la obtención de caudales máximos para el diseño de los diferentes elementos de drenaje, no se han utilizado los datos sobre caudales máximos proporcionados por la administración hidráulica debido a que en la zona de proyecto no se encuentran disponibles. Al tratarse de un proyecto de características singulares se realiza el cálculo de los mismos.

La metodología empleada para de estimación de los caudales de avenida de cada una de las cuencas vertientes al CTNT asociados a los distintos periodos de retorno considerados, se especifica en la normativa 5.2-IC "Drenaje Superficial", y se desarrolla en el capítulo 2 del Anejo 4 "Climatología e Hidrología". Estos caudales son imprescindibles para el dimensionamiento de los elementos de drenaje.

En el anejo de Climatología e hidrología se muestran los cálculos de los caudales de cada cuenca para diferentes periodos de retorno. Es en este anejo en el que para el diseño de los elemento de drenaje se utiliza el caudal correspondiente al periodo de retorno establecido según la tipología del elemento. Tal y como se indica en los Términos de Referencia del presente proyecto, las obras de drenaje transversal se han diseñado considerando un periodo de retorno de 100 años, las cunetas y bajantes se han diseñado para un periodo de retorno de 25 años y, los demás elementos de drenaje han sido comprobados para los caudales correspondientes en cada caso.

Se ha tenido en cuenta lo expuesto a continuación:

- K_A (adimensional) Factor reductor de la precipitación por área de la cuenca. Al ser A < 1 km^2 , se toma Ka = 1.
- En el caso de las ODT, de acuerdo con el Caudal para Tr=100 años se establecen para el cálculo los siguientes parámetros Pd =88,80 mm y Po = 41,54 mm, y en el caso de las cunetas los valores de Pd y Po como 69.28 mm y 34,62 mm respectivamente.
- Los cálculos relativos al máximo caudal anual, la intensidad de precipitación, y la escorrentía superficial, siguen las directrices de cálculo definidas en el anejo de climatología e hidrología, así como los cálculos necesarios para conseguir tales valores.

A continuación se definen los trabajos necesarios para realizar el diseño de los diferentes elementos de drenaje para el proyecto CTNT.

Así mismo cabe indicar, tal y como se refleja en los planos de DRENAJE del presente documento, que no se ha interceptado el gaseoducto existente que cruza el ámbito del proyecto.

4. DIMENSIONAMIENTO DEL DRENAJE LONGITUDINAL Y TRANSVERSAL

4.1. DRENAJE TRANSVERSAL

4.1.1. Planteamiento General

El drenaje transversal de los circuitos tiene la función de proporcionar un medio para que el agua superficial que escurre por cauces naturales o artificiales, en forma permanente o eventual, pueda atravesar bajo las plataformas de los circuitos sin causar daños a éstos. Las obras de drenaje transversal deberán perturbar lo menos posible la circulación del agua por su curso natural.

El proyecto del drenaje transversal se ha abordado conforme a la sistemática habitual para el diseño de ODTs. En primer lugar se han estudiado las cuencas principales para obtener los caudales de proyecto en las secciones donde se ubican las obras de drenaje transversal de acuerdo con el método Racional descrito en norma 5.2-IC de Drenaje Superficial de la Instrucción de Carreteras. Posteriormente, en función de los caudales de punta obtenidos se ha determinado un diámetro para cada una de las obras y se ha verificado su capacidad hidráulica para un caudal de 100 años de periodo de retorno conforme a los Términos de Referencia.

La comprobación hidráulica de las obras de drenaje se ha realizado mediante el programa HY-8 Programa para el cálculo y diseño de obras de drenaje transversal realizado por la FHWA de EE.UU. Este programa nos permite obtener los datos más relevantes para la comprobación hidráulica de las ODTs según el manual de "Obras pequeñas de paso: Dimensionamiento hidráulico" publicado por la Dirección General de Carreteras. Este manual se refiere al método promulgado por el Bureau of Public Roads (actual FHWA, Federal Highway Administration) que es el mismo que el método usado por el software. Al introducir los datos de partida referentes a las cotas de entrada y salida de la ODT, longitud de la ODT, cota de la rasante de la carretera y el caudal vertiente, se obtienen los valores de la altura de la lámina de agua en diferentes secciones de la ODT, pudiendo valorarse la capacidad, la tipología del control y las elevaciones del agua tanto a la entrada como a la salida de la misma de cara a la comprobación final.

En el Apéndice1: "RESULTADO CÁLCULOS ODT HY-8"pueden encontrarse los cálculos realizados para el dimensionamiento de las ODTs del óvalo, mientras que el apéndice 2: ""RESULTADO CÁLCULOS ODTI HY-8" contiene los cálculos realizados para las obras de drenaje de los circuitos y caminos interiores al óvalo.

4.1.2. Elementos de drenaje transversal

Para el óvalo exterior del CTNT se proponen 13 obras de drenaje transversal. Para el dimensionamiento de las mismas se han obtenido los caudales de diseño teniendo en cuenta la afección del los circuitos interiores en términos de drenaje. En el interior del centro tecnológico las obras propuestas son un total de 35.

En cuanto a dimensiones mínimas, se ha tenido en cuenta el capítulo 4 de la Instrucción 5.2.-IC, valorando las posibles variaciones permitidas por los Términos de Referencia del Proyecto. Bien es cierto que la norma recomienda unas dimensiones mínimas de las ODTs en función de su longitud; estas recomendaciones han sido tenidas en cuenta pero se ha valorado la instalación de diámetros inferiores a los propuestos para abaratar el coste de las mismas y teniendo en cuenta que las obras de drenaje transversal cumplen en todo momentos con el condicionante recogido en los TdR de que la altura de las embocaduras de la ODT sea al menos 1,2 veces la altura libre del conducto (HE < 1,2 H).

El encaje de las obras se ha realizado sobre el perfil transversal del cauce ajustando la pendiente de la obra con la de aquél, respetando en lo posible la pendiente existente. El resguardo mínimo exigido por la norma 5.2. – I.C. en su apartado 1.2. B entre el máximo nivel de la lámina de agua y la superficie de la plataforma para elementos de drenaje superficial de la plataforma es de 0,5 (cero coma cinco) metros. Este resguardo se ha tenido en cuenta a la hora de diseñar las ODT.

Cada conducto tiene una curva característica, que relaciona el caudal que desagua a través de él con la cota que alcanza la lámina de agua inmediatamente aguas arriba. Para definir esa curva característica se diferencian dos tipos de control -o secciones determinantes- que pueden producirse en el régimen hidráulico del desagüe: control de entrada o control de salida. Según lo establecido en los TdR del proyecto, la orientación de las ODTs se ajusta a un control en la entrada, cumpliéndose HW < 1,2 D, de forma que el conducto fluye con superficie de agua libre en la sección de control y la entrada no es sumergida, a fin de evitar daños en las zonas adyacentes.

4.1.3. Características de las ODTs

El material propuesto para su construcción es tubo de hormigón armado; para su localización se han tenido en cuenta las características geotécnicas de los terrenos donde se ubican las obras, los costes de las posibles tipologías y los sistemas de ejecución. Con respecto a las embocaduras y desembocaduras se han contemplado aletas y solera de hormigón armado de una pieza.

La escorrentía producida en la zona deprimida BALSA1, representada en el plano de cuencas (figuras 1 y 2), no será desaguada por ninguna ODT sino que se recoge en la balsa propuesta cercana a la glorieta G1.

4.1.3.1. ODT ÓVALO

En la siguiente tabla se relacionan las obras de drenaje transversal al óvalo, con caudal Q correspondiente a Tr= 100 y sus características principales. Los resultados de la comprobación hidráulica con el programa HY-8. Se pueden consultar en el Apéndice 1: “RESULTADO CÁLCULOS ODT HIGHSPEEDOVAL HY-8”.

ODT	Q Diseño (m3/s)	Sección	Longitud (m)	Pendiente longitudinal	Cota entrada (m)	Cota rasante (m)	Cota salida (m)	Veloc salida (m/s)	Hw (m)	1.2*D	Hw<1,2*D
OD-HSO-6+942	2,379	1X1500	35,69	0,50%	774,27	776,69	774,09	2,44	1,18	1,8	OK
OD-HSO-7+040	0,049	1X800	33,47	1,00%	775,53	777,14	775,18	1,2	0,18	0,96	OK
OD-HSO-7+180	0,174	1X1800	40,48	2,50%	775,32	779,47	774,31	2,07	0,26	2,16	OK
OD-HSO-1+605	1,041	1X1800	31,5	1,80%	782,99	787,33	782,43	2,88	0,66	2,16	OK
OD-HSO-1+780	0,198	1X1800	31,66	2,10%	783,26	787,61	782,61	2,04	0,28	2,16	OK
OD-HSO-1+347	0,318	1X1800	28,56	1,30%	783,45	786,91	783,08	1,97	0,36	2,16	OK
OD-HSO-2+253	1,325	1X1800	31,31	0,40%	783,88	788,37	783,77	1,99	0,85	2,16	OK
OD-HSO-2+950	0,72	1X1800	40,41	0,50%	784,52	787,46	784,32	1,78	0,55	2,16	OK
OD-HSO-3+231	0,293	1X1500	37,55	0,50%	784,88	787,25	784,69	1,41	0,37	1,8	OK
OD-HSO-3+927	0,137	1X1800	33,53	0,60%	788,98	792,94	788,78	1,17	0,23	2,16	OK
OD-HSO-4+726	0,467	1X1000	27,23	1,40%	789,26	791,34	788,89	2,28	0,53	1,2	OK
OD-HSO-0+868	0,445	2X600	27,82	0,80%	784,91	786,12	784,69	1,65	0,45	0,72	OK
OD-HSO-0+120	0,296	1X1200	34,2	2,20%	780,85	783,11	780,1	2,44	0,39	1,44	OK

Tabla 1. Información ODTs óvalo

4.1.3.2. ODT CIRCUITOS INTERIORES

En el interior del circuito, el procedimiento de cálculo de los caudales de diseño para las ODT ha sido análogo. Se ha aproximado un área de cuenca vertiente a cada ODT, y siguiendo el método explicado con anterioridad, se han obtenido los resultados de los caudales de diseño.

Los resultados obtenidos, se han comprobado con el programa HY-8. Estos resultados se pueden consultar en el Apéndice 2: ""RESULTADO CÁLCULOS ODT CIRCUITOS INTERIORES HY-8.

En las siguientes tablas se relacionan, ordenadas por circuitos, las obras de drenaje interiores al óvalo, con caudal Q correspondiente a Tr= 100 y sus características principales.

1. LOOP

ODT	Q Diseño (m3/s)	Sección	Longitud (m)	Pendiente longitudinal	Cota entrada (m)	Cota rasante (m)	Cota salida (m)	Veloc salida (m/s)	Hw (m)	1.2*D	Hw<1,2*D
OD-LOP-1+131	0,374	1x600	10,32	1,35%	776,92	778,32	776,78	2,17	0,63	0,72	OK
OD-LOP-1+220	0,023	1x600	12,32	0,50%	777,830	779,07	777,77	0,83	0,14	0,72	OK
OD-LOP-0+000	0,029	1x600	9,25	1,00%	791,24	792,39	791,15	1,05	0,16	0,72	OK
OD-LOP-0+370	0,155	1x600	10,95	0,50%	788,67	789,81	788,62	1,37	0,39	0,72	OK
OD-LOP-0+490	0,206	1x600	13,39	1,20%	785,640	787,65	785,48	1,8	0,43	0,72	OK
OD-LOP-0+740	0,291	1x600	15,24	1,20%	781,540	783,02	781,36	1,97	0,53	0,72	OK
OD-LOP-0+950	0,160	1x600	9,28	0,50%	778,92	780,09	778,88	1,4	0,4	0,72	OK

Tabla 2. Información ODTs LOOP

2. WET HANDLING

ODT	Q Diseño (m3/s)	Sección	Longitud (m)	Pendiente longitudinal	Cota entrada (m)	Cota rasante (m)	Cota salida (m)	Veloc salida (m/s)	Hw (m)	1.2*D	Hw<1,2*D
OD-WEH-0+575	0,020	1x600	22,33	0,50%	789,39	790,56	789,28	0,83	0,15	0,72	OK
OD-WEH-0+735	0,116	1X600	33,42	3,90%	788,33	789,89	787,02	2,35	0,29	0,72	OK
OD-WEH-1+348	0,130	1X600	27,27	0,80%	788,95	790,55	788,73	1,45	0,33	0,72	OK
OD-WEH-0+328	0,056	1X600	27,8	0,50%	789,71	791,9	789,57	1,07	0,25	0,72	OK
OD-WEH-1+278	0,070	1X600	28,89	0,80%	789,56	790,9	789,34	1,47	0,23	0,72	OK

Tabla 3. Información ODTs WET HANDLING

3. DRY HANDLING

ODT	Q Diseño (m3/s)	Sección	Longitud (m)	Pendiente longitudinal	Cota entrada (m)	Cota rasante (m)	Cota salida (m)	Veloc salida (m/s)	Hw (m)	1.2*D	Hw<1,2*D
OD-DRH-0+360	0,59	1X1200	38,24	0,50%	785,94	790,01	785,75	2,61	0,56	1,44	OK
OD-DRH-1+200	0,29	1X1000	30,65	0,50%	788,13	790,3	787,97	1,48	0,41	1,2	OK
OD-DRH-3+105	0,02	1X600	33,12	0,50%	787,69	788,87	787,55	0,83	0,15	0,72	OK
OD-DRH-1+480	0,15	1X800	28,64	0,50%	787,42	788,87	787,28	1,26	0,32	0,96	OK
OD-DRH-1+600	0,04	1X800	29,4	0,50%	787,57	788,98	787,43	0,92	0,18	0,96	OK
OD-DRH-0+832	0,54	1X1000	29,72	0,50%	786,48	788,88	786,32	1,74	0,59	1,2	OK
OD-DRH-2+777	0,02	1X600	70,8	0,50%	789,18	790,45	789,02	0,83	0,15	0,72	OK
OD-DRH-2+908	0,03	1X800	29,28	0,50%	788,42	789,8	788,28	0,87	0,16	0,96	OK
OD-DRH-2+540	0,01	1X800	29,14	0,20%	788,94	790,36	788,88	0,67	0,1	0,96	OK
OD-DRH-2+270	0,14	1X800	28,7	0,50%	788,1	789,52	788,03	1,24	0,31	0,96	OK

Tabla 4. Información ODTs DRY HANDLING

4. WET CIRCLE

ODT	Q Diseño (m3/s)	Sección	Longitud (m)	Pendiente longitudinal	Cota entrada (m)	Cota rasante (m)	Cota salida (m)	Veloc salida (m/s)	Hw (m)	1.2*D	Hw<1,2*D
OD-WCI-0+565	0,02	1X600	20,34	0,50%	790,28	791,65	790,17	0,76	0,13	0,72	OK
OD-WCI-0+265	0,04	1X800	39,54	0,50%	790,03	791,43	789,71	0,96	0,15	0,96	OK
OD-WCI-0+110	0,01	1X600	19,5	0,50%	790,45	791,65	790,38	0,61	0,08	0,72	OK

Tabla 5. Información ODTs WET CIRCLE

5. BRACKING TRACKS

ODT	Q Diseño (m3/s)	Sección	Longitud (m)	Pendiente longitudinal	Cota entrada (m)	Cota rasante (m)	Cota salida (m)	Veloc salida (m/s)	Hw (m)	1.2*D	Hw<1,2*D
OD-BTR1-0+140	0,06	1X600	12,43	0,50%	789,78	790,98	789,72	1,07	0,24	0,72	OK
OD-BTR2-0+240	0,02	1X600	8,61	0,35%	789,88	791,17	789,85	0,83	0,15	0,72	OK
OD-BTR1-0+245	0,02	1X600	44,76	0,35%	789,32	790,9	789,16	0,83	0,15	0,72	OK
OD-BTR2-0+360	0,01	1X600	7,96	0,35%	789,87	791	789,85	0,7	0,11	0,72	OK

Tabla 6. Información ODTs BRACKING TRACKS

6. OVERRUN

ODT	Q Diseño (m3/s)	Sección	Longitud (m)	Pendiente longitudinal	Cota entrada (m)	Cota rasante (m)	Cota salida (m)	Veloc salida (m/s)	Hw (m)	1.2*D	Hw<1,2*D
OD-OVE-0+227	0,234	1X600	10,8	2,40%	789,75	791,33	789,33	2,7	0,45	0,72	OK

Tabla 7. Información ODTs OVERRUN

7. VIALES Y OTROS

ODT	Q Diseño (m3/s)	Sección	Longitud (m)	Pendiente longitudinal	Cota entrada (m)	Cota rasante (m)	Cota salida (m)	Veloc salida (m/s)	Hw (m)	1.2*D	Hw<1,2*D
OD-G1LOP-0+100	0,059	1X600	12,53	0,50%	788,98	792,94	788,78	1,24	0,32	0,72	OK
OD-G1G2-0+065	0,109	1X600	10,91	0,50%	787,97	789,26	787,92	1,03	0,22	0,72	OK
OD-ACC1-0+020	0,037	1X600	18,82	0,20%	791,69	792,74	791,65	0,92	0,19	0,72	OK
OD-G2DRH-0+340	0,06	1X600	10,13	0,50%	791,47	792,85	791,41	0,6	0,07	0,72	OK
OD-G2DRH-0+710	0,047	1X600	10,92	0,50%	789,97	791,15	789,95	0,98	0,21	0,72	OK

Tabla 8. Información ODTs VIALES Y OTROS

4.2. DRENAJE LONGITUDINAL

4.2.1. Planteamiento General

La finalidad perseguida con el diseño de los distintos elementos que forman parte del drenaje longitudinal es la recogida de las aguas pluviales que llegan a las márgenes de la calzada del óvalo y del resto de circuitos para su posterior evacuación.

Los propósitos de la evacuación de agua llevada a cabo por el drenaje longitudinal son:

- Evitar que el agua invada total o parcialmente la plataforma o permanezca en ella.
- Evitar infiltraciones perjudiciales para el firme.
- Evitar deterioro en los taludes de desmonte o terraplén por erosión.
- Evitar infiltraciones en los terraplenes, que los podría desestabilizar.

En primer lugar, es necesario evacuar el área recogida directamente por la plataforma, lo que se realiza principalmente por escorrentía superficial, ya que los firmes de calidad son muy cerrados, e impiden la infiltración del agua de escorrentía a través de ellos. El agua es enviada a un lateral de la calzada donde es recogida por las cunetas correspondientes, y posteriormente enviada al exterior de la explanación del vial.

Paralelamente a la carretera se dispondrán las cunetas anteriormente mencionadas para recoger las aguas pluviales de escorrentía que pudieran circular por la calzada o por aquellas superficies que vierten hacia la infraestructura de la misma. Así, se dispondrán cunetas en los bordes de calzada de los tramos dispuestos en desmonte y se dispondrán cunetas de pie de terraplén en las zonas donde exista.

Además en estas zonas de terraplén, se incluyen bordillos dispuestos de manera longitudinal con zonas de bajantes cada 30 metros para evitar que el agua proveniente de la calzada pueda erosionar los taludes hasta su recogida en los elementos de drenaje correspondiente, en este caso las cunetas de pie de terraplén.

Todas estas cunetas se dispondrán de forma continua, desaguando a las obras de drenaje existentes. Se aconseja un adecuado mantenimiento de las mismas, ya que en caso contrario se podría llegar a provocar obstrucciones en la cuneta. Las cunetas serán de sección triangular y trapecial. Se procurará dotarlas con pendientes iguales a la de rasante del eje del trazado excepto en la proximidades de puntos bajos en acuerdos cóncavos con escasa pendiente, donde se adoptan pendientes mayores para evitar aterramientos.

En cumplimiento del artículo 3.4.2.2. de la Instrucción 5.2-IC, se emplearán cunetas revestidas de hormigón salvo justificación de lo contrario. Además, siempre que la pendiente longitudinal sea superior al 3% (para evitar fenómenos de erosión) o inferior al 1% (para facilitar el movimiento de las aguas), cuando se considere necesario para evitar infiltraciones o cuando la velocidad de agua supere la máxima admisible correspondiente a la naturaleza de la superficie sin revestir. En el caso del CTNT se propone el revestimiento de todas las cunetas con hormigón.

En el caso de estas cunetas revestidas de hormigón, la velocidad admisible es de 4,5 – 6 m/s, y el espesor de revestimiento será de 10 cm.

En las zonas donde se encuentra propuesta la urbanización, el agua será transportada al lateral de la calzada y recogida en caces con arquetas-sumidero y para luego canalizarla por un colector central para evitar su acumulación. Este colector se conectará con el desagüe general del CTNT.

4.2.2. Elementos del drenaje longitudinal

A continuación se describen los principales elementos de drenaje longitudinal proyectados para evacuar el agua de escorrentía que recoge la plataforma y las zonas adyacentes a la misma. El agua procedente de la plataforma, de los taludes de desmontes o terraplenes, y de algunas aportaciones de pequeñas cuencas es transportada mediante las cunetas y los tubos colectores a los diferentes puntos de desagüe.

Los elementos principales que componen el sistema de drenaje longitudinal proyectado son:

Cunetas de intercepción: interceptan el agua que recogen en la cuenca que les da nombre y que lo conducen hacia su evacuación exterior, se dimensionan con un caudal de diseño para un periodo de retorno de Tr 25 años.

Cunetas de plataforma: situadas en los tramos en desmonte, en la parte baja del talud de éstos con el fin de recoger las aguas procedentes del mismo y de la plataforma.

Cunetas de pie de terraplén: se dispondrán paralelo a éste en las zonas de terraplén, a fin de recoger el agua vertiente al mismo, a la carretera y la escorrentía del terreno adyacente en caso necesario. En el óvalo principal, están directamente conectadas con las bajantes prefabricadas de 0,6 m de ancho que se proyectan cada 20 m, cuya misión es conducir el agua a la cuneta y así proteger el derrame de tierras del terreno del terraplén.

La capacidad hidráulica de la misma ha sido comprobada mediante la herramienta de Software FlowMaster, programa cálculo de dinámica de fluidos. En el apéndice 3 pueden observarse los resultados obtenidos para las diferentes tipologías de cunetas que conforman las cunetas interiores y exteriores del óvalo.

4.2.2.1. Cunetas de intercepción

A continuación se muestra una tabla con los caudales de diseño de las mismas así como los parámetros característicos para su cálculo.

Denominación	S (km)	Tc (h)	Pd (mm/24h)	I (mm/h)	C	Q (m3/s)
CUNETA-G1LOP-0+430	0,002	0,71	69,28	40,10	0,26	0,006
CUNETA-DRH-1+900	0,002	0,61	69,28	35,81	0,15	0,002
CUNETA-DRH-2+400	0,000	0,32	69,28	29,38	0,15	0,001
CUNETA-DRH-0+100	0,014	1,07	69,28	29,38	0,15	0,018
CUNETA-DRH-2+175	0,020	0,91	69,28	30,38	0,15	0,026

Denominación	S (km)	Tc (h)	Pd (mm/24h)	I (mm/h)	C	Q (m3/s)
CUNETA-HSO-6+942-2	0,013	0,54	69,28	25,69	0,92	0,137
CUNETA-HSO-6+942-3	0,004	1,21	69,28	25,41	0,62	0,021
CUNETA-HSO-6+942-4	0,013	0,28	69,28	28,07	0,63	0,131
CUNETA-HSO-6+942-5	0,007	0,91	69,28	38,31	0,64	0,037
CUNETA-HSO-6+942-6	0,005	0,81	69,28	44,86	0,61	0,031
CUNETA-HSO-6+942-7	0,017	0,30	69,28	25,69	0,51	0,143
CUNETA-HSO-6+942-1	0,004	1,40	69,28	42,48	0,18	0,006
CUNETA-HSO-7+235	0,008	0,58	69,28	58,43	0,39	0,036
CUNETA-HSO-2+700	0,043	0,35	69,28	30,43	0,18	0,115
CUNETA-HSO-2+780	0,040	0,35	69,28	30,43	0,18	0,106
CUNETA-HSO-2+860	0,003	0,98	69,28	32,50	0,18	0,005
CUNETA-HSO-3+100	0,052	0,30	69,28	56,36	0,21	0,171
CUNETA-HSO-3+540	0,032	1,18	69,28	56,36	0,37	0,092
CUNETA-HSO-4+700	0,008	0,90	69,28	58,32	0,56	0,039
CUNETA-HSO-4+510	0,005	1,07	69,28	58,32	0,57	0,025
CUNETA-HSO-0+320	0,001	0,73	69,28	33,75	0,18	0,002
CUNETA-VIAL-G2DRH	0,005	0,66	69,28	31,12	0,26	0,014
CUNETA-OVE-0+445	0,032	0,81	69,28	37,24	0,17	0,051
CUNETA-OVE-0+330	0,012	0,76	69,28	28,52	0,23	0,026
CUNETA-OVE-0+100	0,014	1,23	69,28	30,33	0,20	0,023

Tabla 9. Q de diseño de las CUNETAS DE GUARDA

El dimensionamiento de las cunetas de plataforma se ha realizado en base al caudal circulante por cada una de ellas.

4.2.2.2. Cunetas de plataforma

Para drenar el agua que discurre por la plataforma, se ha diseñado una cuneta de plataforma. En cada uno de los circuitos se define una tipología. La comprobación hidráulica de estas cunetas se ha realizado con el programa Flow master según se ha descrito en líneas precedentes. A continuación se muestra la tipología escogida para cada circuito.

Óvalo

Para el drenaje de la plataforma del óvalo se ha considerado una cuneta tipo II, Estas cunetas son de sección triangular y de 0.17 m de profundidad, y se colocan en las zonas de desmonte.

En las zonas donde la capacidad de la cuneta sea inferior al caudal calculado se dispondrá de un dren colector con arquetas sumidero colocadas cada 50 m como en adelante se detalla.

La comprobación hidráulica se ha hecho en base a la siguiente curva de capacidad que relaciona las pendientes longitudinales de las cunetas con el caudal que soportan.

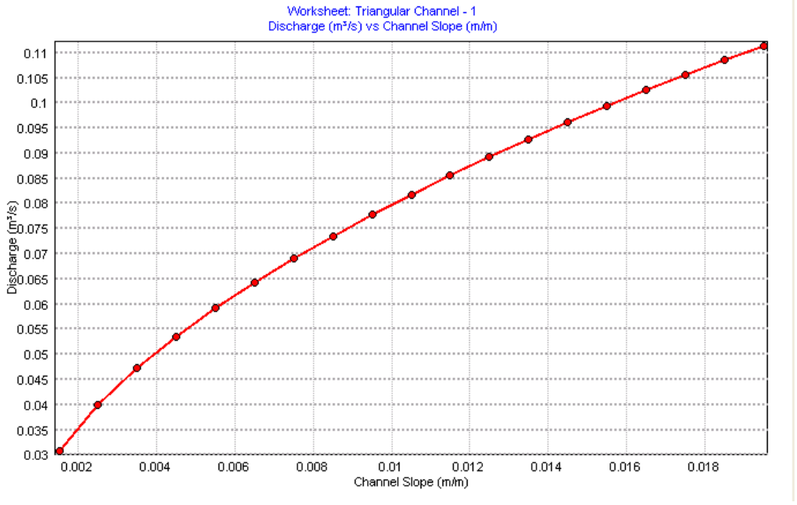


Tabla 10. Curva de capacidad de la cuneta de plataforma del óvalo

La comprobación de las cunetas del óvalo se ha realizado según la ODT a la que vierten:

- Para la cuneta que vierte a la ODT 6+942

Cuenca (aportaciones)	Pendiente longitudinal	Superficie (m2)	Tc (h)	Q Tr 25 (m3/s)	Comprobación
CUNETA-HSO-6+942-1	0,002	4491,81	1,398	0,006	Sin dren colector
CUNETA-HSO-6+942-2	0,002	12686,87	0,541	0,143	Con dren colector
CUNETA-HSO-6+942-3	0,002	4321,4	1,212	0,280	Con dren colector
CUNETA-HSO-6+942-4	0,002	12647,58	0,849	0,440	Con dren colector
CUNETA-HSO-6+942-5	0,020	6532,18	1,032	0,577	Con dren colector
CUNETA-HSO-6+942-6	0,020	5328,63	0,814	0,735	Con dren colector
CUNETA-HSO-6+942-7	0,020	17499,27	0,295	0,886	Con dren colector

Tabla 11. Comprobación Cuneta que vierte a OD-HSO-6+942

Aparte de las aportaciones de las cuencas relacionadas en la tabla, también aportan caudal las siguientes cuencas: BAJANTE-HSO-6+560, BAJANTE-HSO-6+570, BAJANTE-HSO-6+420, BAJANTE-HSO-6+140 y OD-HSO-6+942.

- Para la cuneta que vierte a la OD-HSO-7+040

No hay cuneta de plataforma, porque no hay desmonte notorio.

- Para la cuneta que vierte a la OD-HSO-7+180

No hay cuneta de plataforma, porque no hay desmonte notorio.

- Para la cuneta que vierte a la OD-HSO-0+120

Cuenca (aportaciones)	Pendiente longitudinal	Superficie (m2)	Tc (h)	Q Tr 25 (m3/s)	Comprobación
OD-HSO-0+120	0,002	34226,93	0,429	0,220	Con dren colector

Tabla 12. Comprobación Cuneta que vierte a OD-HSO-0+120

Esta cuneta recibe aportación de caudal de CUNETA-HSO-0+320

- Para la cuneta que vierte a la OD-HSO-0+868

Cuenca (aportaciones)	Pdte. Media	Superficie (m2)	Tc (h)	Q Tr 25 (m3/s)	Comprobación
BAJANTE-HSO-0+680	0,003	34966,7	1,210	0,075	Con dren colector
OD-HSO-0+868	0,003	41183,6	0,878	0,033	Sin dren colector

Tabla 13. Comprobación Cuneta que vierte a OD-HSO-0+868

- Para la cuneta que vierte a la OD-HSO-1+347

No hay cuneta de plataforma, porque no hay desmonte entre los pKs correspondientes

- Para la cuneta que vierte a la OD-HSO-1+605

No hay cuneta de plataforma, porque no hay desmonte entre los pKs correspondientes.

- Para la cuneta que vierte a la OD-HSO-1+780

Cuenca (aportaciones)	Pdte. Media	Superficie (m2)	Tc (h)	Q Tr 25 (m3/s)	Comprobación
OD-HSO-1+780	0,002	45923,720	0,760	0,037	Con dren colector

Tabla 14. Comprobación Cuneta que vierte a OD-HSO-1+780

- Para la cuneta que vierte a la OD-HSO-2+253

OD-HSO-2+253	0,002	152661,260	0,393	0,075	Con dren colector
OD-HSO-2+253	0,002	152661,260	0,393	0,075	Con dren colector

Tabla 15. Comprobación Cuneta que vierte a OD-HSO-2+253

Esta cuneta recibe aportación de caudal de OD-G2DRH-0+710 y de OD-DRH-0+360

- Para la cuneta que vierte a la OD-HSO-2+950

Cuenca (aportaciones)	Pendiente longitudinal	Superficie (m2)	Tc (h)	Q Tr 25 (m3/s)	Comprobación
OD-HSO-2+950	0,005	19804,340	0,688	0,348	Con dren colector
CUNETA-HSO-3+100	0,005	52215,170	0,304	0,043	Sin dren colector

Tabla 16. Comprobación Cuneta que vierte a OD-HSO-2+950

Esta cuneta recibe aportación de caudal de CUNETA-HSO-2+700, CUNETA-HSO-2+780 y CUNETA-HSO-2+860.

- Para la cuneta que vierte a la OD-HSO-3+231

Cuenca (aportaciones)	Pendiente longitudinal	Superficie (m2)	Tc (h)	Q Tr 25 (m3/s)	Comprobación
OD-HSO-3+231	0,010	35989,770	0,906	0,083	Con dren colector

Tabla 17. Comprobación Cuneta que vierte a OD-HSO-3+231

Esta cuneta recibe aportación de caudal de CUNETA-HSO-3+540 y de CUNETA-HSO-3+300.

- Para la cuneta que vierte a la OD-HSO-3+927

No hay cuneta de plataforma, porque no hay desmonte entre los pKs correspondientes

- Para la cuneta que vierte a la OD-HSO-4+726

Cuenca (aportaciones)	Pendiente longitudinal	Superficie (m2)	Tc (h)	Q Tr 25 (m3/s)	Comprobación
OD-HSO-4+726	0,002	11854,100	0,275	0,114	Con dren colector

Tabla 18. Comprobación Cuneta que vierte a OD-HSO-4+726

Esta cuneta recibe aportación de caudal de CUNETA-HSO-4+510, CUNETA-OVE-0+445 CUNETA-OVE-0+330 y OD-OVE-0+227.

Circuitos interiores

En cuanto a las cunetas que pertenecen a los distintos circuitos interiores, se ha utilizado la misma, sección trapezoidal descrita en los planos de detalle como Cuneta tipo IV, para las diferentes cunetas, tanto de pie de terraplén como de desmonte. Al igual que anteriormente, la capacidad hidráulica de la misma ha sido comprobada mediante la herramienta de Software FlowMaster. A continuación se muestra una imagen de dicha sección:

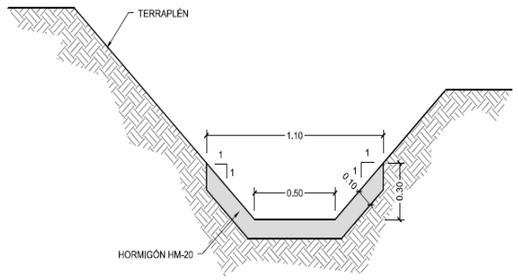


Figura 3. Sección tipo de las cunetas de los circuitos internos

4.3. OTROS ELEMENTOS DE DRENAJE

4.3.1. Bajantes

Las bajantes que desaguan una parte del terreno y acaban en una cuneta para su drenaje al exterior, se dimensionan, tal y como señala el TdR con un caudal Q calculado para un Tr de 25 años

En el presente proyecto, hay un total de 10 cuencas que desaguan en bajantes prefabricadas que conducen agua de una cuenca determinada para su evacuación al exterior. A continuación se muestra el caudal de diseño para cada una de ellas, así como los parámetros principales para el cálculo del mismo.

Denominación	S (km)	Tc (h)	Pd (mm/24h)	I (mm/h)	C	Q (m3/s)
BAJANTE-HSO-6+560	0,005	0,64	69,28	35,19	0,18	0,009
BAJANTE-HSO-5+280	0,018	1,02	69,28	52,60	0,18	0,028
BAJANTE-HSO-5+160	0,008	0,92	69,28	52,60	0,18	0,013

Denominación	S (km)	Tc (h)	Pd (mm/24h)	I (mm/h)	C	Q (m3/s)
BAJANTE-HSO-5+045	0,006	0,87	69,28	47,00	0,18	0,011
BAJANTE-HSO-5+480	0,028	0,38	69,28	47,00	0,18	0,072
BAJANTE-HSO-6+570-TERRENO	0,003	0,42	69,28	28,37	0,18	0,007
BAJANTE-HSO-6+570	0,003	0,59	69,28	28,37	0,18	0,006
BAJANTE-HSO-6+420	0,012	0,74	69,28	40,84	0,18	0,021
BAJANTE-HSO-6+140	0,008	0,30	69,28	25,78	0,18	0,024
BAJANTE-HSO-0+680	0,035	1,21	69,28	25,78	0,28	0,075

Tabla 19. Q de diseño de las BAJANTES

Hay dos bajantes que dada su importancia de ubicación y la magnitud de las aguas que recogen se han diseñado escalonadas y dimensionado para un caudal con un periodo de retorno de 100 años. A continuación se expone su caudal de diseño y parámetros considerados para el cálculo del mismo:

Denominación	S (km)	Tc (h)	Pd (mm/24h)	I (mm/h)	C	Q (m3/s)
BAJANTE 1-G1G2-0+065	0,014	0,95	88,80	36,06	0,31	0,049
BAJANTE 2-HSO-0+700	0,035	1,21	88,80	33,04	0,29	0,102

Tabla 20. Q de diseño de las BAJANTES PREFABRICADAS

4.3.2. Colectores

Será preciso disponer de colectores para saneamiento de pluviales con tubo de hormigón. Estos colectores se han dimensionado en base a un caudal Q para un Tr de 100 años.

Denominación	S (km)	Tc (h)	Pd (mm/24h)	I (mm/h)	C	Q (m3/s)
COL-G1LOP-0+575	2148,97	0,66	88,80	73,80	0,41	0,012
COL-G1LOP-0+390	1603,4	0,50	88,80	51,40	0,45	0,011
COL-BTR4-0+020	3159,97	0,71	88,80	38,94	0,34	0,01
COL-BTR2-0+520	860,87	0,49	88,80	44,88	0,43	0,01

Tabla 21. Q de diseño de los COLECTORES

4.3.3. Pasos salvacuneta

En aquellos puntos en los que los caminos de acceso o los circuitos interceptan con alguna cuneta y con el fin de garantizar la continuidad de la misma, será preciso disponer de pasos salvacuneta bajo el referido entronque y siguiendo la alineación de la cuneta.

Estos pasos salvacuneta están constituidos por tubos de sección circular de características análogas al resto de las obras de drenaje y diámetros acordes con las necesidades hidráulicas.

4.3.4. Arquetas y arquetas sumidero

Las arquetas son los elementos que sirven de recogida de agua en el drenaje profundo, asegurando a su vez la inspección y conservación de los elementos enterrados de desagüe (drenes profundos y colectores). Por lo general, se colocan con una separación mínima aconsejable de 50 metros e inferior a 100 metros.

Estas arquetas, también se conectan a las ODTs para dar salida a las cunetas existentes entre el óvalo exterior y el camino perimetral.

4.3.5. Dren colector

Se diseña un dren colector para la recogida de las aguas del firme y la cuneta, en el interior del óvalo.

El diámetro del dren colector varía según el tramo de cuneta. El dren colector se ha diseñado con diámetros variables en función de la capacidad de la cuneta, existiendo dren colector de 600 mm y de 800 mm.

Este dren colector se proyecta en las zonas interiores de desmonte del óvalo y un dren en la zona exterior del óvalo. Con esto se mejora la capacidad hidráulica de la cuenta en el interior y se protege el firme en las zonas de desmonte tanto en el interior como el exterior del óvalo.

El dren colector recogerá el agua proveniente del firme y de infiltración del terreno aledaño en zonas de desmonte, además de conducir el agua recogida por la cuneta hasta su descarga, mientras que el dren recogerá el agua que se infiltre a través del terreno en zonas de desmonte

Siguiendo las recomendaciones para el proyecto y construcción del drenaje subterráneo en obras de carretera, obtenemos la estimación de caudal recogida por el tubo drenante.

En nuestro caso, según el capítulo 2.1.1.1. Infiltración vertical de la citada en la orden circular, consideramos que el pavimento en la calzada y arcenes, son esencialmente impermeables, por lo que solamente tendremos infiltración proveniente del terreno en zonas de desmonte.

Madrid, noviembre de 2017,

Fdo: Eva Martín Salgado
Ing. Técnico Obras Públicas

APÉNDICE 1

RESULTADO CÁLCULOS ODT HIGHSPEEDOVAL HY-8

HY-8 Culvert Analysis Report

Site Data - 6+942

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 774.27 m

Outlet Station: 35.69 m

Outlet Elevation: 774.09 m

Number of Barrels: 1

Culvert Data Summary - 6+942

Barrel Shape: Circular

Barrel Diameter: 1500.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 6+942

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
2.38	2.38	775.45	1.182	0.274	1-S2n	0.770	0.795	0.791	0.454	2.438	2.238
2.44	2.44	775.47	1.200	0.826	1-S2n	0.781	0.804	0.803	0.462	2.452	2.256
2.50	2.50	775.49	1.218	0.847	1-S2n	0.793	0.815	0.815	0.469	2.466	2.274
2.56	2.56	775.51	1.236	0.867	1-S2n	0.804	0.825	0.804	0.477	2.565	2.291
2.62	2.62	775.52	1.254	0.887	1-S2n	0.816	0.835	0.816	0.484	2.579	2.308
2.67	2.67	775.54	1.272	0.907	1-S2n	0.827	0.845	0.827	0.492	2.592	2.324
2.73	2.73	775.56	1.289	0.928	1-S2n	0.839	0.854	0.839	0.499	2.605	2.341
2.79	2.79	775.58	1.307	0.949	1-S2n	0.850	0.865	0.850	0.506	2.618	2.357
2.85	2.85	775.59	1.324	0.970	1-S2n	0.862	0.874	0.862	0.514	2.630	2.372
2.91	2.91	775.61	1.342	0.991	1-S2n	0.873	0.884	0.873	0.521	2.642	2.388
2.97	2.97	775.63	1.359	1.012	1-S2n	0.885	0.893	0.885	0.528	2.654	2.403

****

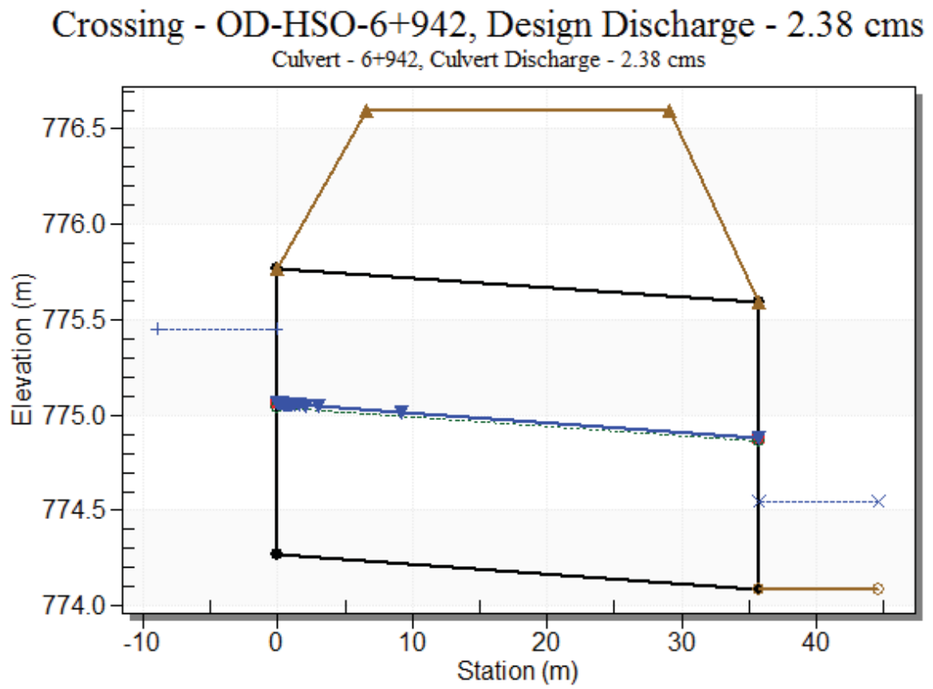
Straight Culvert

Inlet Elevation (invert): 774.27 m, Outlet Elevation (invert): 774.09 m

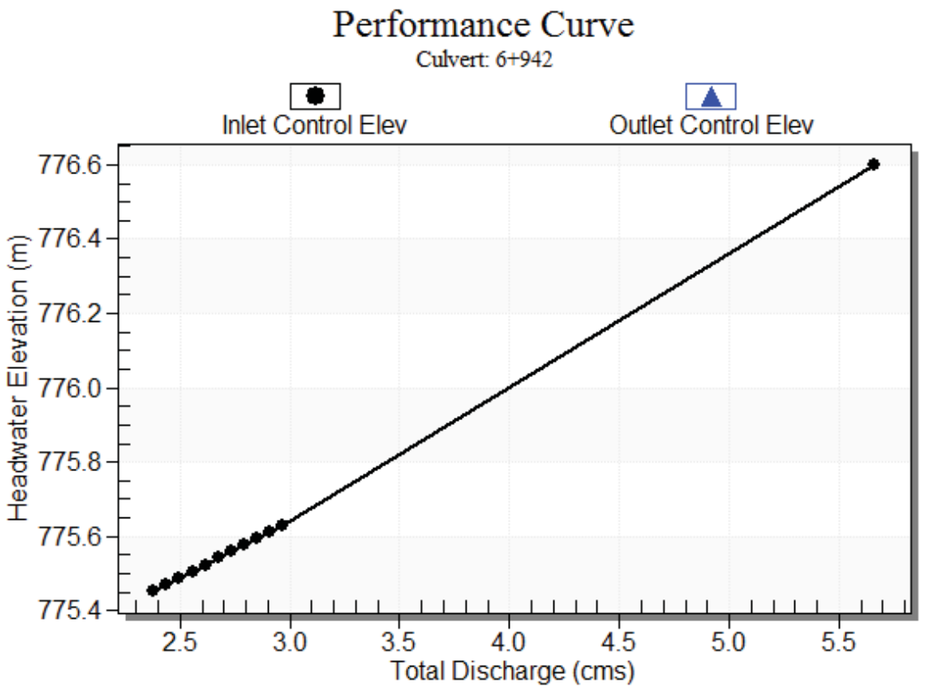
Culvert Length: 35.69 m, Culvert Slope: 0.0050

****

Water Surface Profile Plot for Culvert: 6+942



Culvert Performance Curve Plot: 6+942



HY-8 Culvert Analysis Report

Site Data - 7+040

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 775.53 m

Outlet Station: 33.47 m

Outlet Elevation: 775.18 m

Number of Barrels: 1

Culvert Data Summary - 7+040

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 7+040

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.05	0.05	775.70	0.174	0.0*	1-S2n	0.108	0.128	0.108	0.039	1.165	0.739
0.05	0.05	775.71	0.176	0.0*	1-S2n	0.109	0.130	0.109	0.039	1.175	0.746
0.05	0.05	775.71	0.178	0.0*	1-S2n	0.111	0.131	0.111	0.040	1.185	0.753
0.05	0.05	775.71	0.181	0.0*	1-S2n	0.112	0.133	0.112	0.040	1.194	0.760
0.05	0.05	775.71	0.183	0.0*	1-S2n	0.113	0.134	0.113	0.041	1.204	0.766
0.06	0.06	775.72	0.185	0.0*	1-S2n	0.114	0.136	0.114	0.041	1.213	0.773
0.06	0.06	775.72	0.187	0.0*	1-S2n	0.116	0.138	0.116	0.042	1.222	0.779
0.06	0.06	775.72	0.189	0.0*	1-S2n	0.117	0.138	0.117	0.042	1.230	0.786
0.06	0.06	775.72	0.190	0.0*	1-S2n	0.118	0.139	0.118	0.043	1.220	0.792
0.06	0.06	775.72	0.192	0.0*	1-S2n	0.119	0.141	0.119	0.044	1.227	0.798
0.06	0.06	775.72	0.194	0.0*	1-S2n	0.121	0.142	0.121	0.044	1.233	0.805

* Full Flow Headwater elevation is below inlet invert.

****

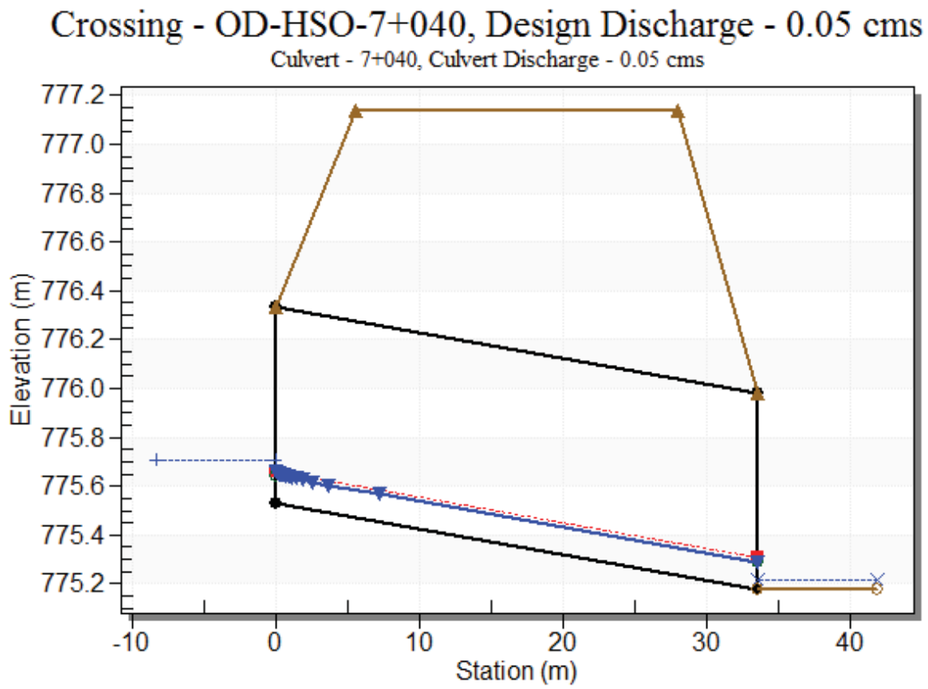
Straight Culvert

Inlet Elevation (invert): 775.53 m, Outlet Elevation (invert): 775.18 m

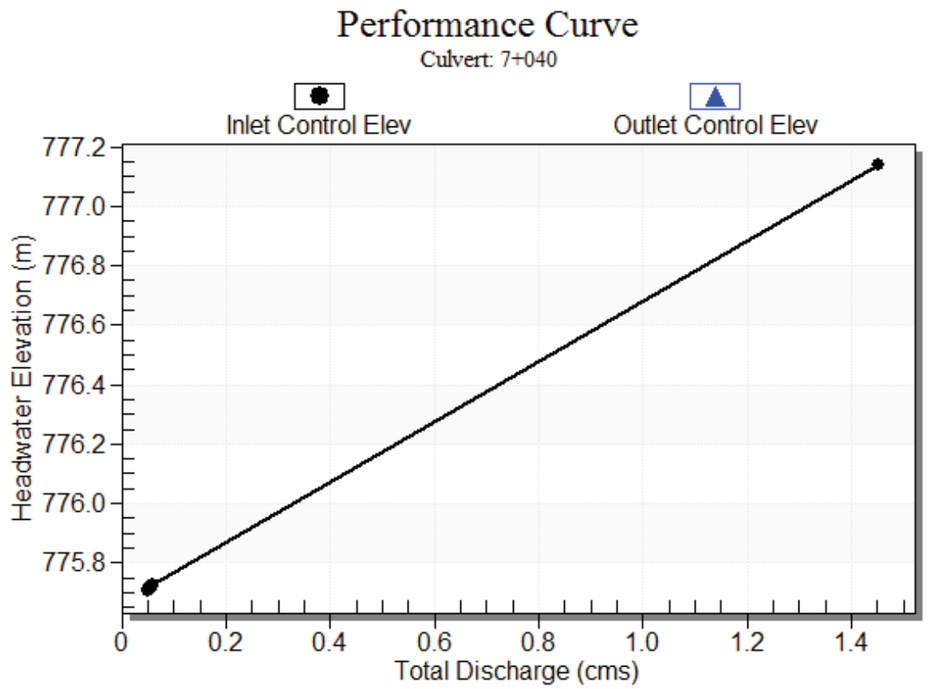
Culvert Length: 33.47 m, Culvert Slope: 0.0105

****

Water Surface Profile Plot for Culvert: 7+040



Culvert Performance Curve Plot: 7+040



HY-8 Culvert Analysis Report

Site Data - 7+180

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 775.32 m

Outlet Station: 40.47 m

Outlet Elevation: 774.31 m

Number of Barrels: 1

Culvert Data Summary - 7+180

Barrel Shape: Circular

Barrel Diameter: 1800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 7+180

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.17	0.17	775.58	0.263	0.0*	1-S2n	0.128	0.196	0.128	0.048	2.071	1.357
0.18	0.18	775.59	0.266	0.0*	1-S2n	0.130	0.199	0.130	0.049	2.083	1.371
0.18	0.18	775.59	0.268	0.0*	1-S2n	0.132	0.201	0.132	0.049	2.095	1.384
0.19	0.19	775.59	0.271	0.0*	1-S2n	0.133	0.204	0.133	0.050	2.107	1.397
0.19	0.19	775.59	0.275	0.0*	1-S2n	0.135	0.206	0.135	0.051	2.118	1.410
0.20	0.20	775.60	0.278	0.0*	1-S2n	0.137	0.208	0.137	0.051	2.129	1.422
0.20	0.20	775.60	0.281	0.0*	1-S2n	0.139	0.211	0.139	0.052	2.140	1.434
0.20	0.20	775.60	0.284	0.0*	1-S2n	0.140	0.213	0.140	0.053	2.162	1.447
0.21	0.21	775.61	0.287	0.0*	1-S2n	0.141	0.216	0.141	0.054	2.183	1.458
0.21	0.21	775.61	0.290	0.0*	1-S2n	0.142	0.218	0.142	0.054	2.203	1.471
0.22	0.22	775.61	0.294	0.0*	1-S2n	0.143	0.220	0.143	0.055	2.223	1.482

* Full Flow Headwater elevation is below inlet invert.

****

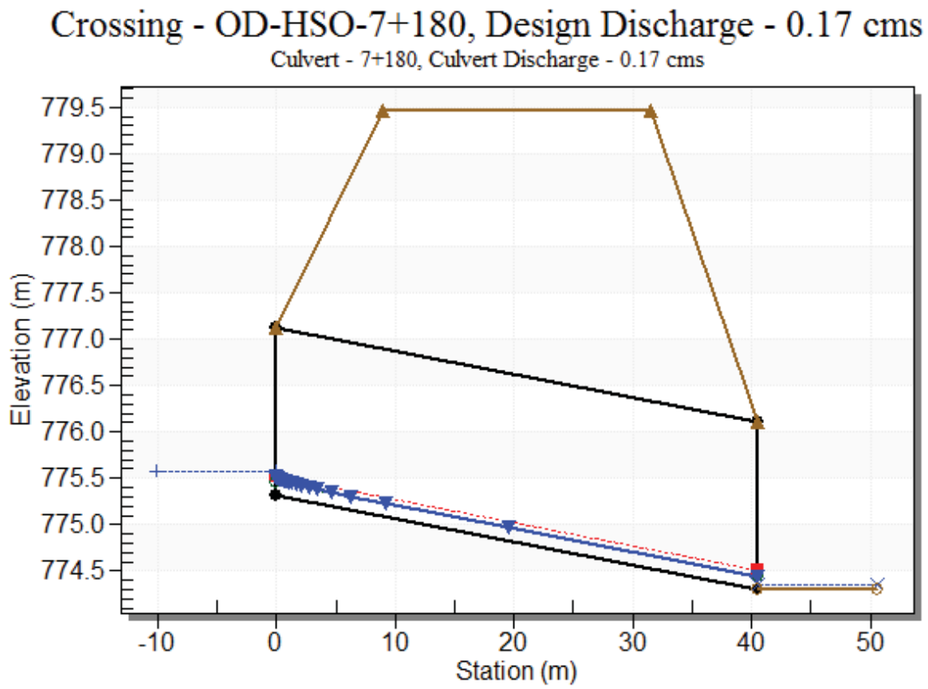
Straight Culvert

Inlet Elevation (invert): 775.32 m, Outlet Elevation (invert): 774.31 m

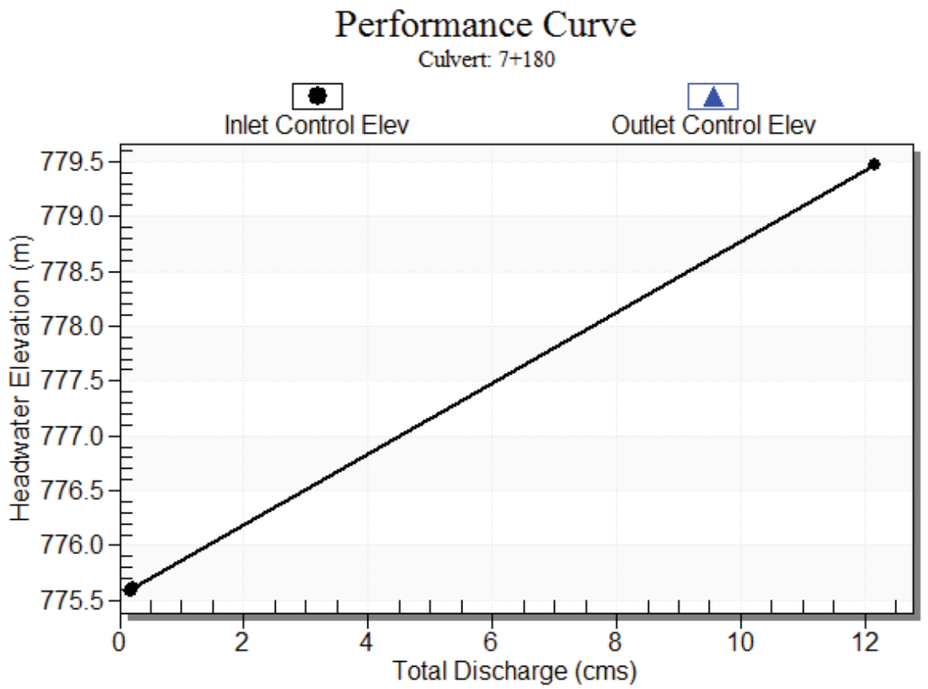
Culvert Length: 40.48 m, Culvert Slope: 0.0250

****

Water Surface Profile Plot for Culvert: 7+180



Culvert Performance Curve Plot: 7+180



HY-8 Culvert Analysis Report

Site Data - 1+605

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 782.99 m

Outlet Station: 31.50 m

Outlet Elevation: 782.43 m

Number of Barrels: 1

Culvert Data Summary - 1+605

Barrel Shape: Circular

Barrel Diameter: 1800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+605

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
1.04	1.04	783.65	0.663	0.0*	1-S2n	0.331	0.489	0.350	0.160	2.876	2.448
1.07	1.07	783.66	0.672	0.0*	1-S2n	0.335	0.495	0.355	0.163	2.895	2.470
1.09	1.09	783.67	0.681	0.0*	1-S2n	0.339	0.502	0.359	0.165	2.919	2.492
1.12	1.12	783.68	0.689	0.0*	1-S2n	0.343	0.508	0.362	0.168	2.945	2.514
1.14	1.14	783.69	0.698	0.0*	1-S2n	0.347	0.514	0.366	0.170	2.973	2.536
1.17	1.17	783.70	0.706	0.0*	1-S2n	0.351	0.520	0.369	0.173	3.003	2.557
1.20	1.20	783.70	0.714	0.0*	1-S2n	0.355	0.526	0.373	0.175	3.021	2.578
1.22	1.22	783.71	0.722	0.0*	1-S2n	0.359	0.532	0.379	0.178	3.026	2.598
1.25	1.25	783.72	0.730	0.001	1-S2n	0.363	0.538	0.384	0.180	3.036	2.619
1.27	1.27	783.73	0.738	0.008	1-S2n	0.366	0.543	0.388	0.182	3.041	2.638
1.30	1.30	783.74	0.746	0.014	1-S2n	0.370	0.549	0.392	0.185	3.056	2.658

* Full Flow Headwater elevation is below inlet invert.

****

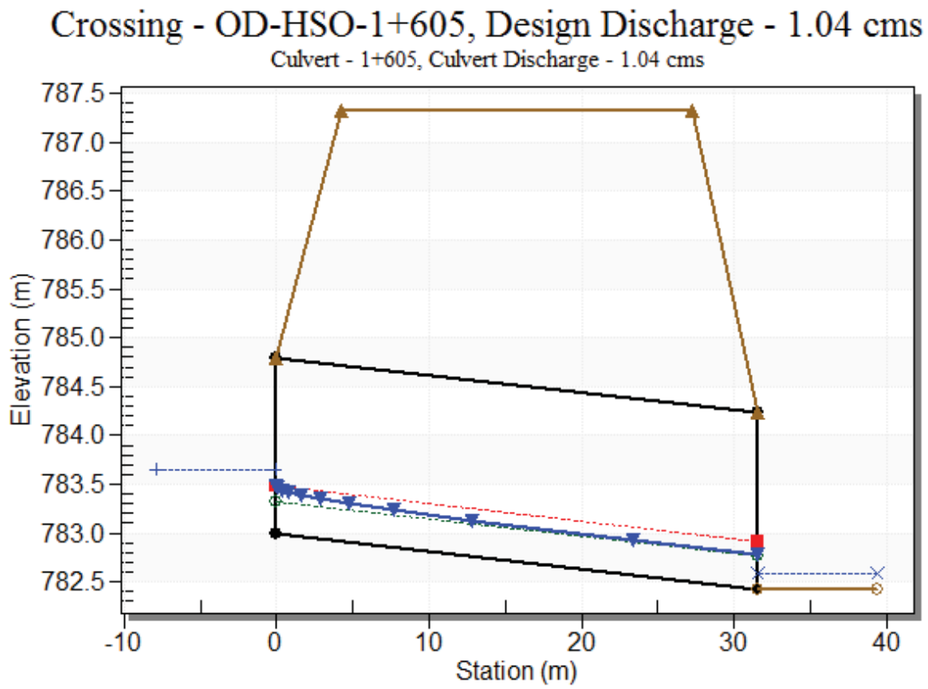
Straight Culvert

Inlet Elevation (invert): 782.99 m, Outlet Elevation (invert): 782.43 m

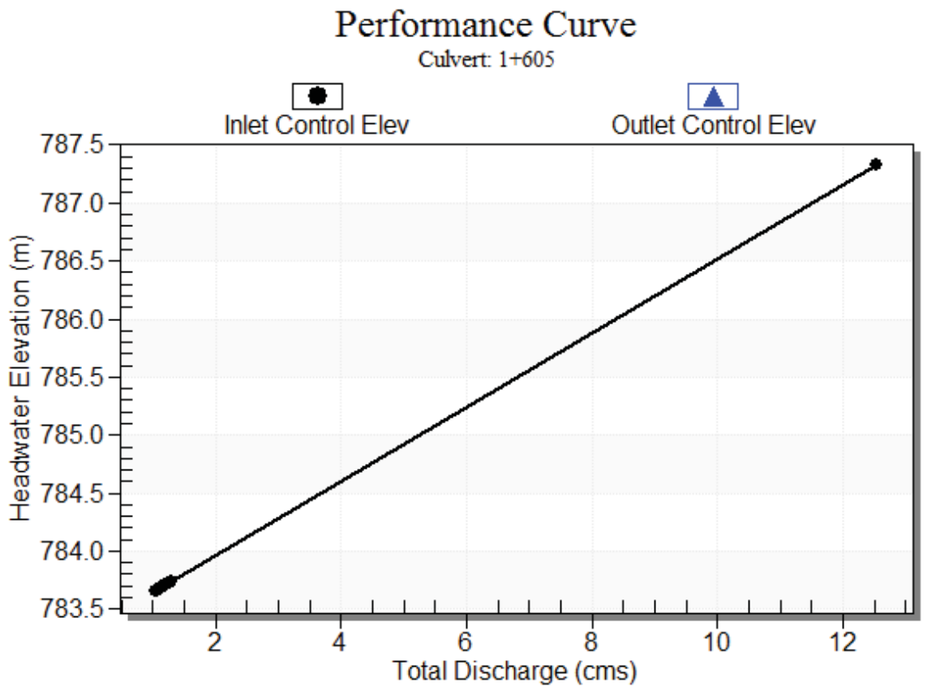
Culvert Length: 31.50 m, Culvert Slope: 0.0178

****

Water Surface Profile Plot for Culvert: 1+605



Culvert Performance Curve Plot: 1+605



HY-8 Culvert Analysis Report

Site Data - 1+780

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 783.26 m

Outlet Station: 31.65 m

Outlet Elevation: 782.61 m

Number of Barrels: 1

Culvert Data Summary - 1+780

Barrel Shape: Circular

Barrel Diameter: 1800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+780

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.20	0.20	783.54	0.280	0.0*	1-S2n	0.144	0.210	0.144	0.055	2.017	1.349
0.20	0.20	783.54	0.284	0.0*	1-S2n	0.145	0.212	0.145	0.056	2.039	1.363
0.21	0.21	783.55	0.287	0.0*	1-S2n	0.147	0.215	0.147	0.057	2.061	1.375
0.21	0.21	783.55	0.291	0.0*	1-S2n	0.148	0.217	0.148	0.058	2.081	1.389
0.22	0.22	783.55	0.294	0.0*	1-S2n	0.150	0.220	0.150	0.059	2.102	1.401
0.22	0.22	783.56	0.298	0.0*	1-S2n	0.151	0.223	0.151	0.060	2.121	1.414
0.23	0.23	783.56	0.301	0.0*	1-S2n	0.153	0.225	0.153	0.060	2.140	1.426
0.23	0.23	783.56	0.305	0.0*	1-S2n	0.154	0.228	0.154	0.061	2.112	1.438
0.24	0.24	783.57	0.308	0.0*	1-S2n	0.156	0.230	0.156	0.062	2.126	1.449
0.24	0.24	783.57	0.312	0.0*	1-S2n	0.157	0.233	0.157	0.063	2.139	1.462
0.25	0.25	783.58	0.315	0.0*	1-S2n	0.159	0.235	0.159	0.064	2.153	1.473

* Full Flow Headwater elevation is below inlet invert.

****

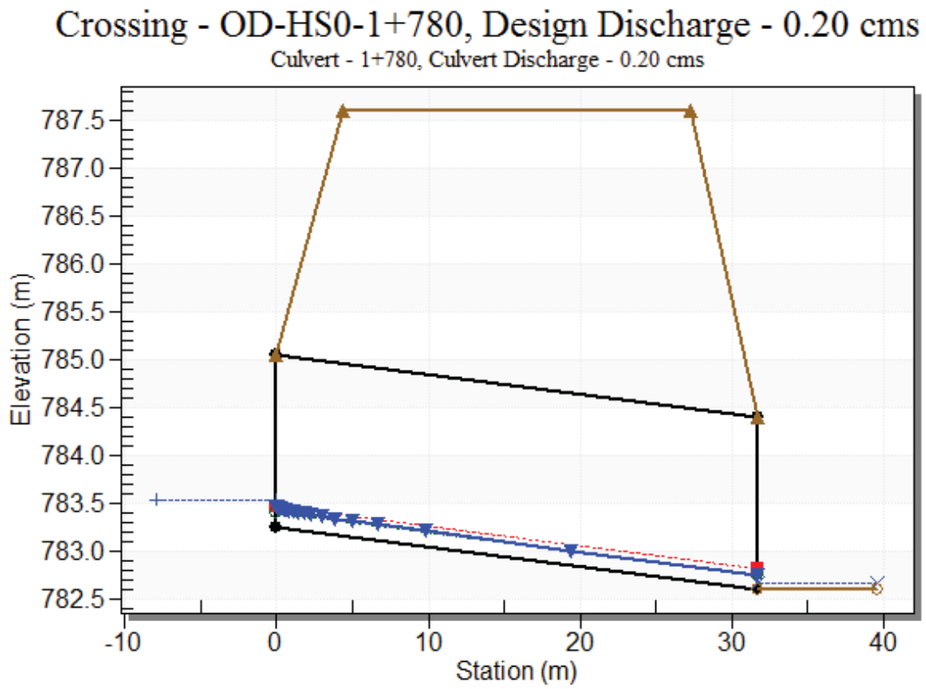
Straight Culvert

Inlet Elevation (invert): 783.26 m, Outlet Elevation (invert): 782.61 m

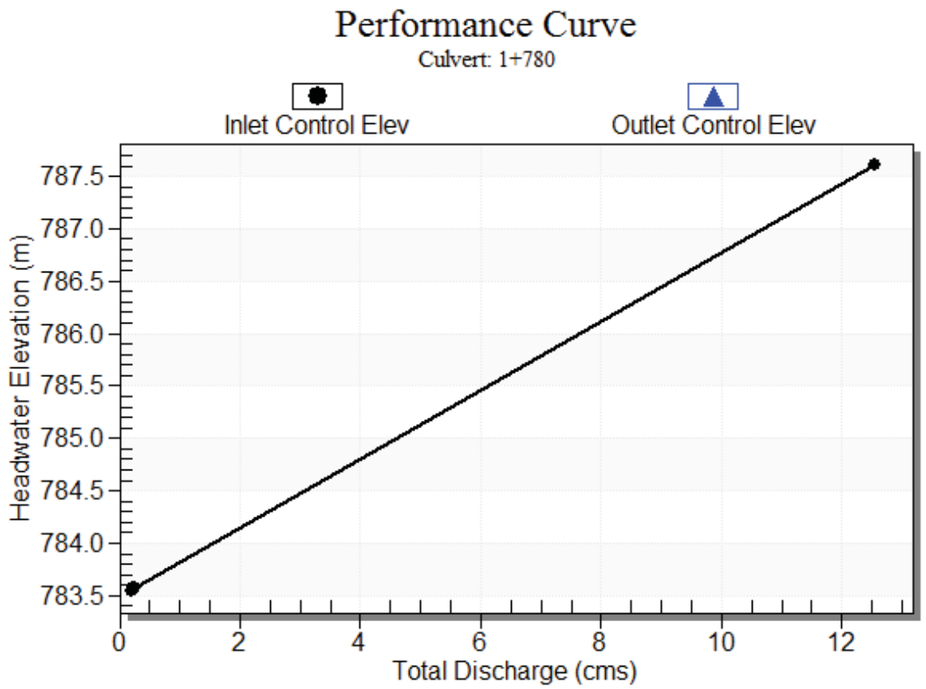
Culvert Length: 31.66 m, Culvert Slope: 0.0205

****

Water Surface Profile Plot for Culvert: 1+780



Culvert Performance Curve Plot: 1+780



HY-8 Culvert Analysis Report

Site Data - 1+347

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 783.45 m

Outlet Station: 28.56 m

Outlet Elevation: 783.08 m

Number of Barrels: 1

Culvert Data Summary - 1+347

Barrel Shape: Circular

Barrel Diameter: 1800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+347

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.32	0.32	783.81	0.360	0.0*	1-S2n	0.200	0.267	0.200	0.085	1.967	1.411
0.33	0.33	783.81	0.364	0.0*	1-S2n	0.203	0.270	0.203	0.086	1.982	1.424
0.33	0.33	783.82	0.369	0.0*	1-S2n	0.205	0.274	0.205	0.088	1.996	1.437
0.34	0.34	783.82	0.374	0.0*	1-S2n	0.208	0.277	0.208	0.089	2.011	1.450
0.35	0.35	783.83	0.378	0.0*	1-S2n	0.210	0.280	0.210	0.090	2.024	1.464
0.36	0.36	783.83	0.383	0.0*	1-S2n	0.212	0.283	0.212	0.091	2.037	1.477
0.37	0.37	783.84	0.387	0.0*	1-S2n	0.215	0.286	0.215	0.093	2.050	1.489
0.37	0.37	783.84	0.392	0.0*	1-S2n	0.217	0.289	0.217	0.094	2.062	1.501
0.38	0.38	783.85	0.395	0.0*	1-S2n	0.219	0.292	0.228	0.095	1.963	1.514
0.39	0.39	783.85	0.399	0.0*	1-S2n	0.222	0.295	0.230	0.096	1.977	1.526
0.40	0.40	783.85	0.403	0.0*	1-S2n	0.224	0.298	0.232	0.098	1.992	1.537

* Full Flow Headwater elevation is below inlet invert.

****

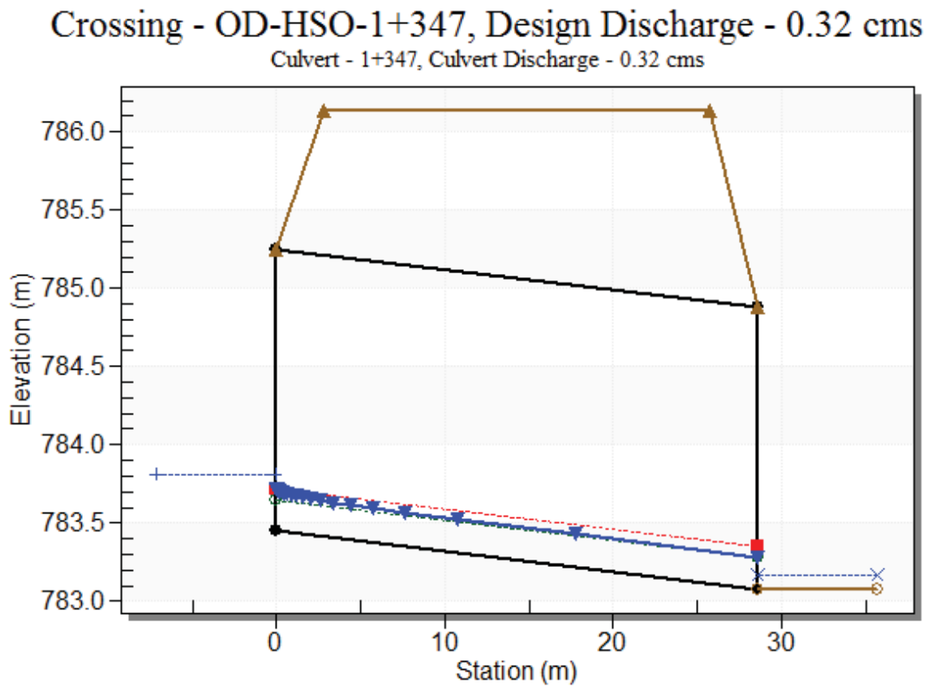
Straight Culvert

Inlet Elevation (invert): 783.45 m, Outlet Elevation (invert): 783.08 m

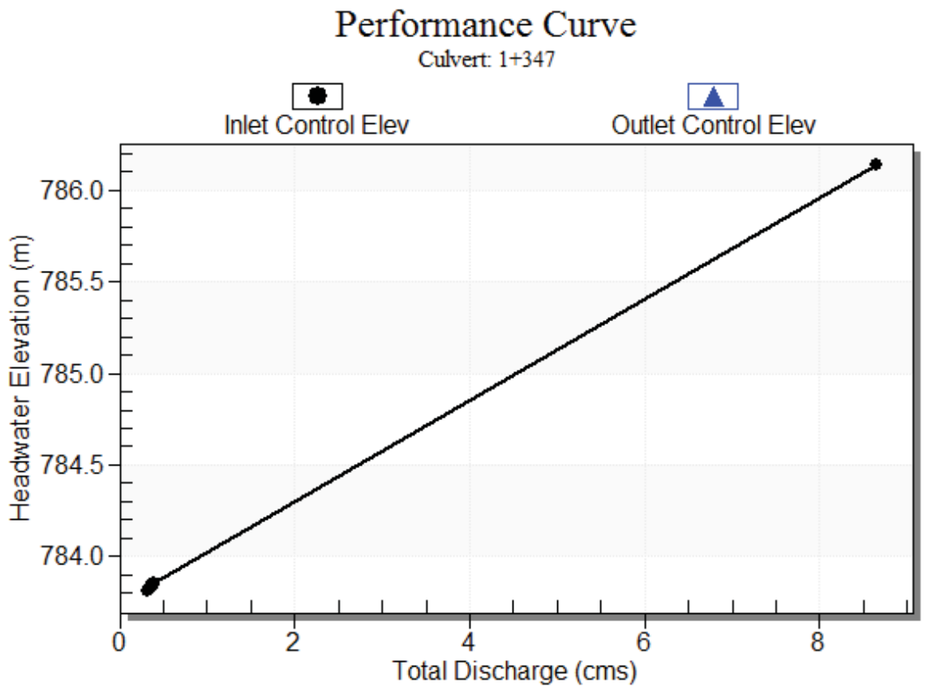
Culvert Length: 28.56 m, Culvert Slope: 0.0130

****

Water Surface Profile Plot for Culvert: 1+347



Culvert Performance Curve Plot: 1+347



HY-8 Culvert Analysis Report

Site Data - 2+253

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 783.88 m

Outlet Station: 31.31 m

Outlet Elevation: 783.77 m

Number of Barrels: 1

Culvert Data Summary - 2+253

Barrel Shape: Circular

Barrel Diameter: 1800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 2+253

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
1.32	1.32	784.73	0.763	0.853	2-M2c	0.564	0.555	0.555	0.315	1.989	1.583
1.36	1.36	784.74	0.773	0.864	2-M2c	0.571	0.562	0.562	0.320	2.003	1.597
1.39	1.39	784.76	0.783	0.875	2-M2c	0.578	0.569	0.569	0.325	2.017	1.611
1.42	1.42	784.77	0.793	0.886	2-M2c	0.586	0.576	0.576	0.330	2.030	1.624
1.46	1.46	784.78	0.802	0.897	2-M2c	0.593	0.583	0.583	0.335	2.043	1.637
1.49	1.49	784.79	0.812	0.908	2-M2c	0.600	0.590	0.590	0.340	2.056	1.650
1.52	1.52	784.80	0.822	0.919	2-M2c	0.607	0.596	0.596	0.345	2.069	1.662
1.56	1.56	784.81	0.831	0.930	2-M2c	0.614	0.602	0.602	0.349	2.087	1.675
1.59	1.59	784.82	0.841	0.940	2-M2c	0.621	0.609	0.609	0.354	2.099	1.687
1.62	1.62	784.83	0.850	0.951	2-M2c	0.628	0.615	0.615	0.359	2.112	1.699
1.66	1.66	784.84	0.859	0.961	2-M2c	0.634	0.622	0.622	0.364	2.124	1.711

****

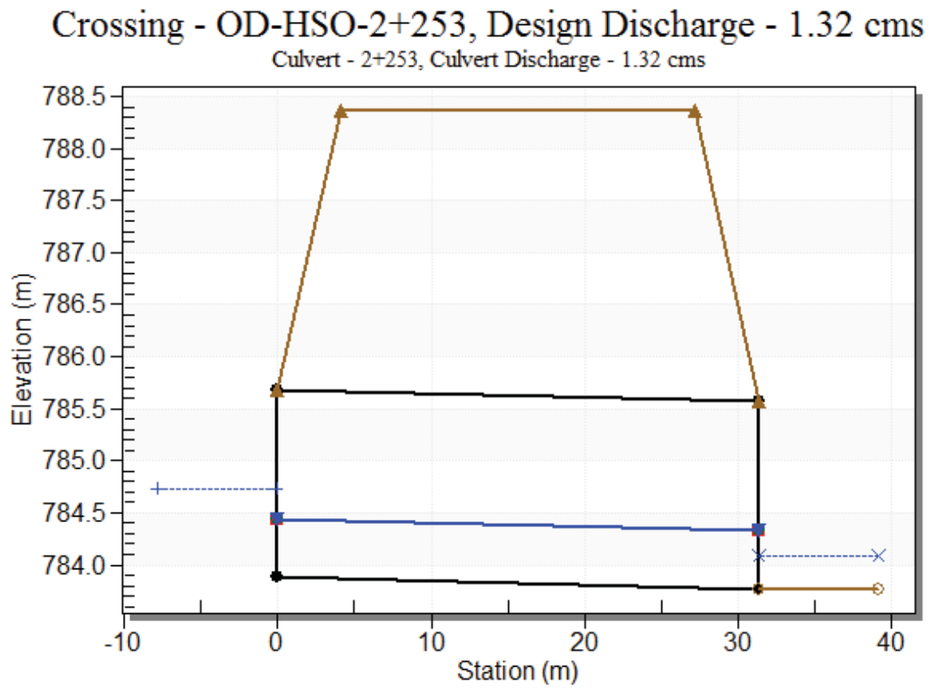
Straight Culvert

Inlet Elevation (invert): 783.88 m, Outlet Elevation (invert): 783.77 m

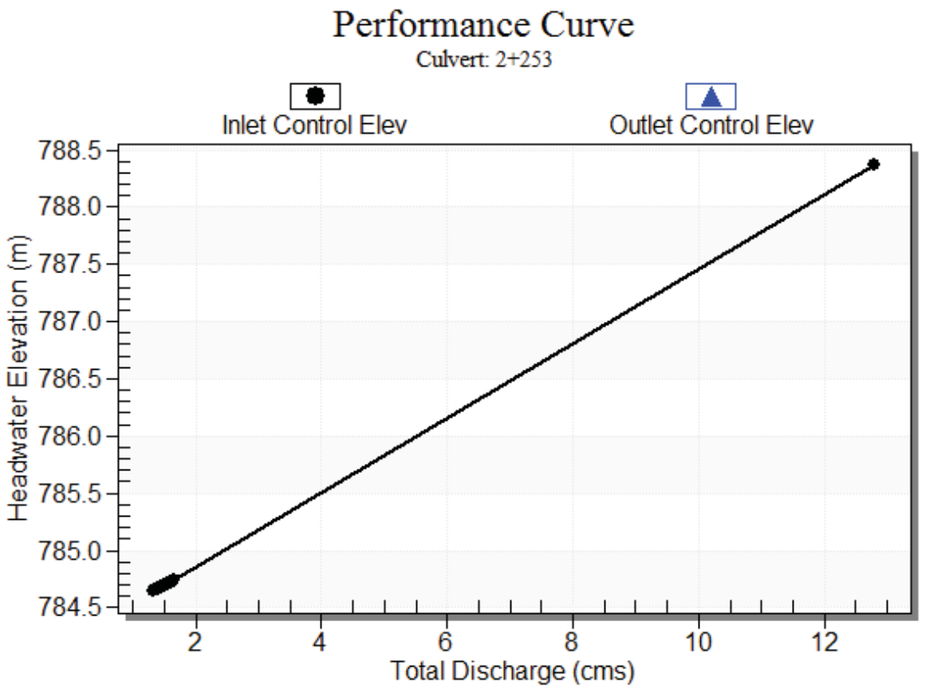
Culvert Length: 31.31 m, Culvert Slope: 0.0035

****

Water Surface Profile Plot for Culvert: 2+253



Culvert Performance Curve Plot: 2+253



HY-8 Culvert Analysis Report

Site Data - 2+950

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 784.52 m

Outlet Station: 40.41 m

Outlet Elevation: 784.32 m

Number of Barrels: 1

Culvert Data Summary - 2+950

Barrel Shape: Circular

Barrel Diameter: 1800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 2+950

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.72	0.72	785.07	0.552	0.0*	1-S2n	0.379	0.405	0.379	0.171	1.782	1.355
0.74	0.74	785.08	0.560	0.219	1-S2n	0.383	0.410	0.383	0.174	1.797	1.367
0.76	0.76	785.09	0.567	0.224	1-S2n	0.388	0.415	0.388	0.176	1.806	1.380
0.77	0.77	785.09	0.574	0.230	1-S2n	0.393	0.421	0.393	0.179	1.818	1.392
0.79	0.79	785.10	0.581	0.235	1-S2n	0.397	0.426	0.397	0.181	1.830	1.404
0.81	0.81	785.11	0.588	0.241	1-S2n	0.402	0.430	0.402	0.184	1.842	1.416
0.83	0.83	785.11	0.594	0.246	1-S2n	0.406	0.435	0.406	0.187	1.853	1.427
0.85	0.85	785.12	0.601	0.252	1-S2n	0.411	0.440	0.423	0.189	1.791	1.439
0.86	0.86	785.13	0.608	0.257	1-S2n	0.415	0.445	0.415	0.192	1.875	1.450
0.88	0.88	785.13	0.614	0.262	1-S2n	0.420	0.450	0.431	0.194	1.816	1.461
0.90	0.90	785.14	0.621	0.266	1-S2n	0.424	0.453	0.424	0.197	1.900	1.472

* Full Flow Headwater elevation is below inlet invert.

****

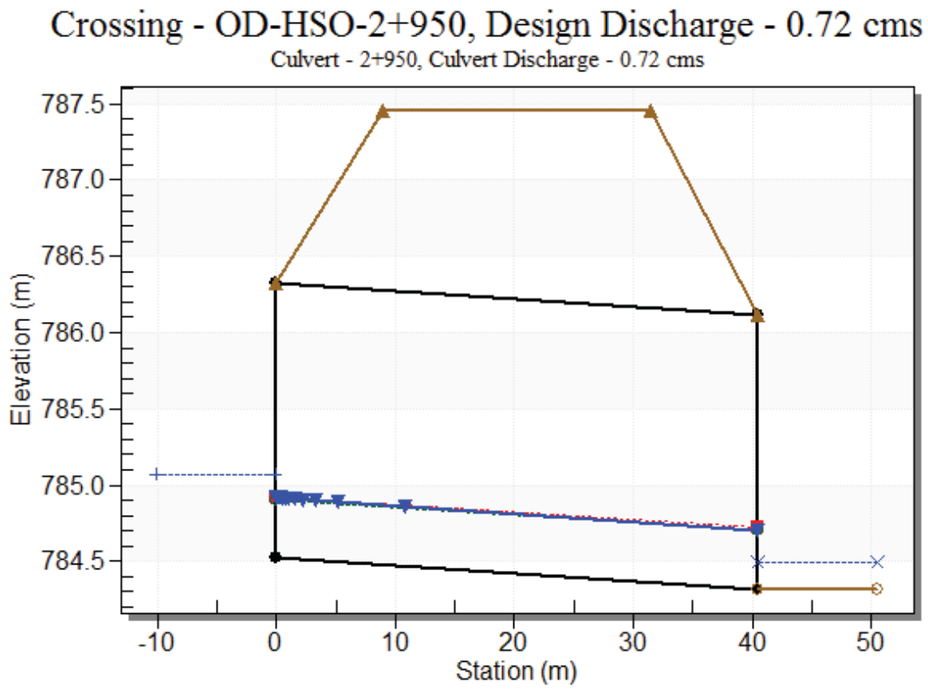
Straight Culvert

Inlet Elevation (invert): 784.52 m, Outlet Elevation (invert): 784.32 m

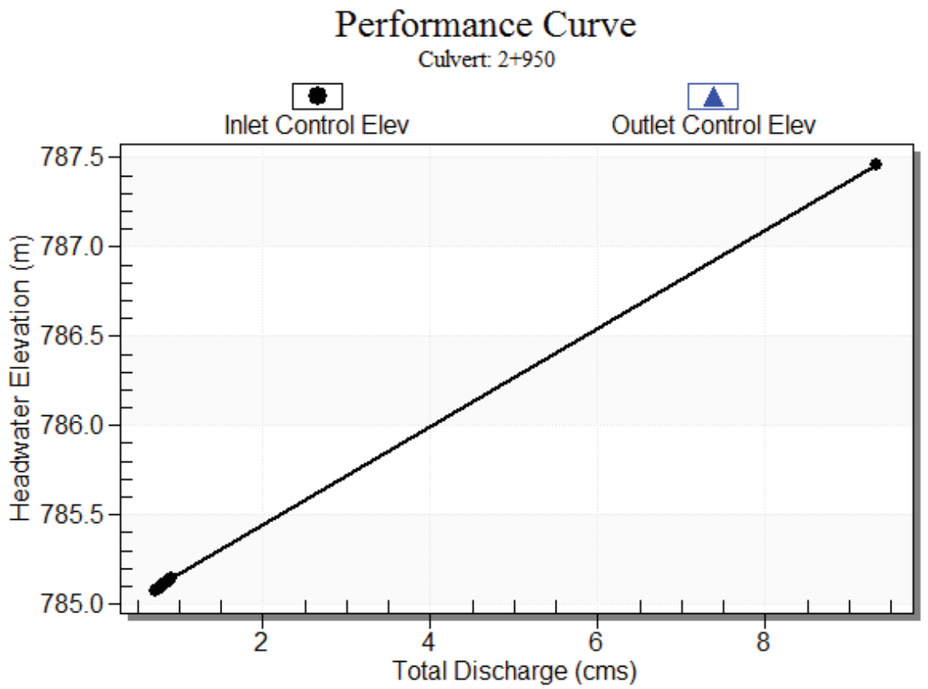
Culvert Length: 40.41 m, Culvert Slope: 0.0049

****

Water Surface Profile Plot for Culvert: 2+950



Culvert Performance Curve Plot: 2+950



HY-8 Culvert Analysis Report

Site Data - 3+231

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 784.88 m

Outlet Station: 37.55 m

Outlet Elevation: 784.69 m

Number of Barrels: 1

Culvert Data Summary - 3+231

Barrel Shape: Circular

Barrel Diameter: 1500.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 3+231

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.29	0.29	785.25	0.366	0.0*	1-S2n	0.256	0.269	0.256	0.117	1.408	1.058
0.30	0.30	785.25	0.371	0.085	1-S2n	0.259	0.272	0.267	0.119	1.362	1.068
0.31	0.31	785.26	0.375	0.089	1-S2n	0.262	0.275	0.262	0.120	1.427	1.078
0.31	0.31	785.26	0.380	0.092	1-S2n	0.265	0.279	0.265	0.122	1.437	1.087
0.32	0.32	785.26	0.385	0.096	1-S2n	0.269	0.282	0.269	0.124	1.445	1.097
0.33	0.33	785.27	0.388	0.099	1-S2n	0.271	0.285	0.271	0.126	1.456	1.106
0.34	0.34	785.27	0.393	0.103	1-S2n	0.274	0.289	0.274	0.127	1.468	1.115
0.34	0.34	785.28	0.397	0.106	1-S2n	0.277	0.292	0.277	0.129	1.479	1.124
0.35	0.35	785.28	0.402	0.109	1-S2n	0.280	0.295	0.280	0.131	1.489	1.133
0.36	0.36	785.29	0.406	0.113	1-S2n	0.283	0.298	0.283	0.133	1.500	1.142
0.37	0.37	785.29	0.410	0.116	1-S2n	0.285	0.301	0.285	0.134	1.503	1.150

* Full Flow Headwater elevation is below inlet invert.

****

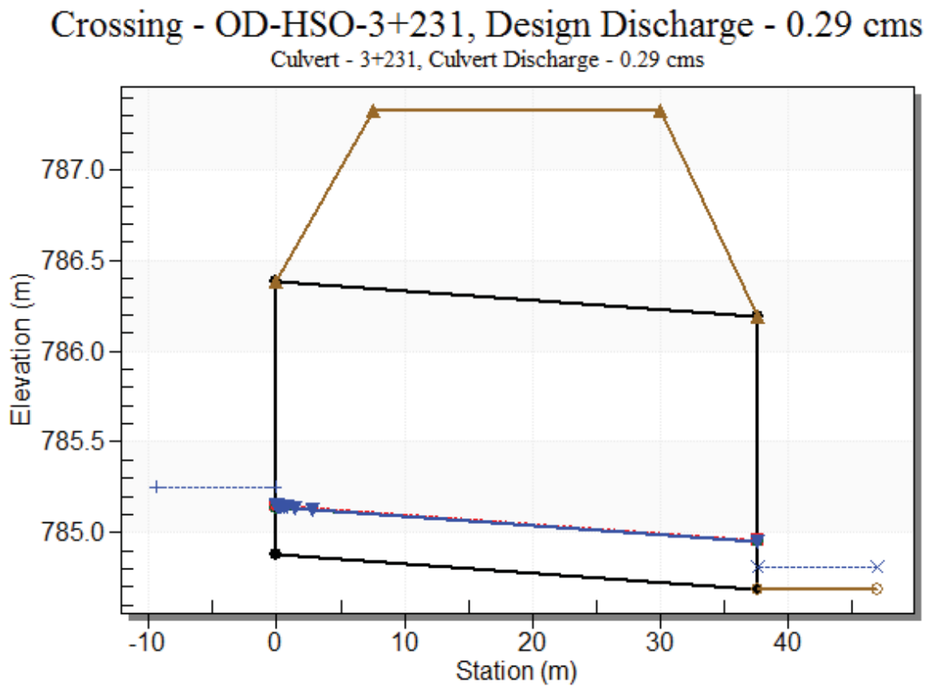
Straight Culvert

Inlet Elevation (invert): 784.88 m, Outlet Elevation (invert): 784.69 m

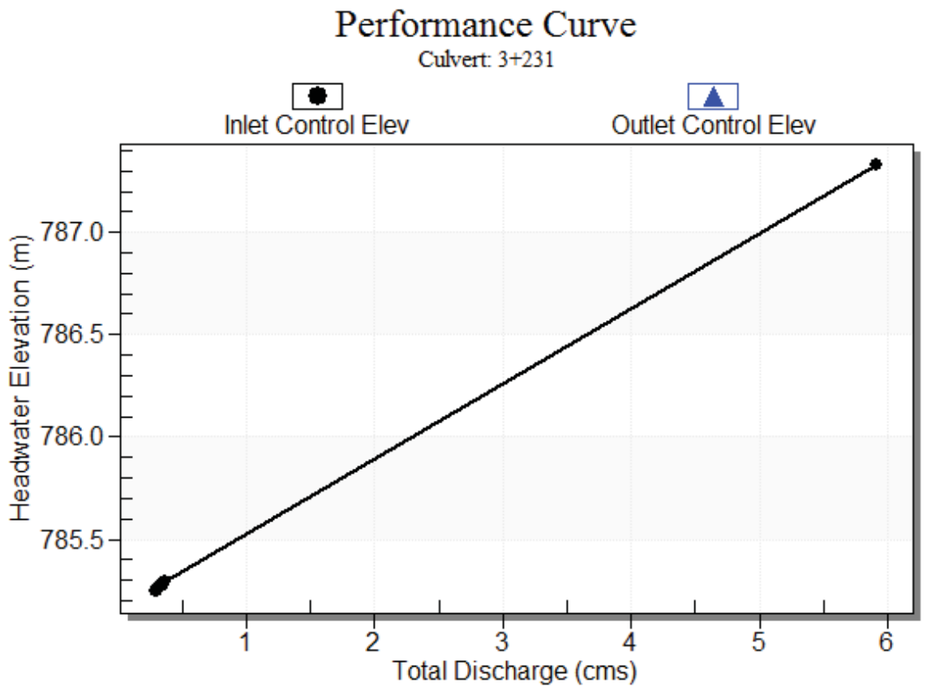
Culvert Length: 37.55 m, Culvert Slope: 0.0051

****

Water Surface Profile Plot for Culvert: 3+231



Culvert Performance Curve Plot: 3+231



HY-8 Culvert Analysis Report

Site Data - 3+927

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.98 m

Outlet Station: 33.53 m

Outlet Elevation: 788.78 m

Number of Barrels: 1

Culvert Data Summary - 3+927

Barrel Shape: Circular

Barrel Diameter: 1800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 3+927

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.14	0.14	789.21	0.235	0.0*	1-S2n	0.161	0.173	0.161	0.064	1.169	0.803
0.14	0.14	789.22	0.238	0.0*	1-S2n	0.163	0.176	0.163	0.065	1.177	0.810
0.14	0.14	789.22	0.241	0.0*	1-S2n	0.165	0.178	0.165	0.066	1.185	0.817
0.15	0.15	789.22	0.244	0.0*	1-S2n	0.166	0.180	0.166	0.067	1.193	0.825
0.15	0.15	789.23	0.247	0.0*	1-S2n	0.168	0.182	0.168	0.068	1.200	0.833
0.15	0.15	789.23	0.250	0.0*	1-S2n	0.170	0.184	0.170	0.069	1.208	0.840
0.16	0.16	789.23	0.253	0.0*	1-S2n	0.172	0.186	0.172	0.070	1.215	0.847
0.16	0.16	789.24	0.256	0.0*	1-S2n	0.174	0.188	0.174	0.071	1.222	0.854
0.16	0.16	789.24	0.259	0.0*	1-S2n	0.176	0.190	0.176	0.072	1.228	0.861
0.17	0.17	789.24	0.261	0.0*	1-S2n	0.178	0.192	0.178	0.073	1.235	0.867
0.17	0.17	789.24	0.264	0.0*	1-S2n	0.180	0.194	0.180	0.074	1.241	0.874

* Full Flow Headwater elevation is below inlet invert.

****

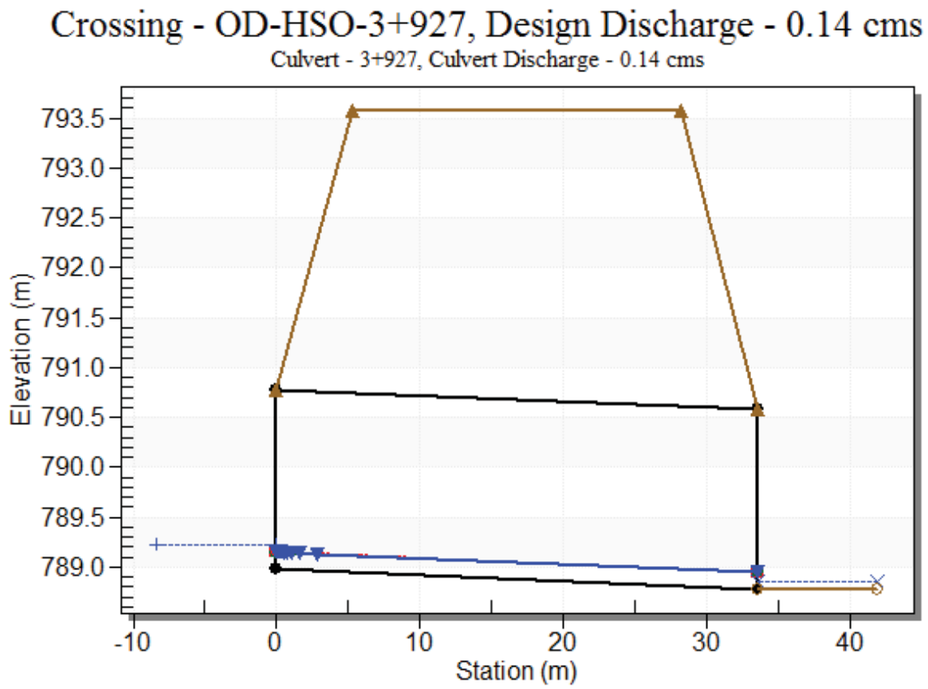
Straight Culvert

Inlet Elevation (invert): 788.98 m, Outlet Elevation (invert): 788.78 m

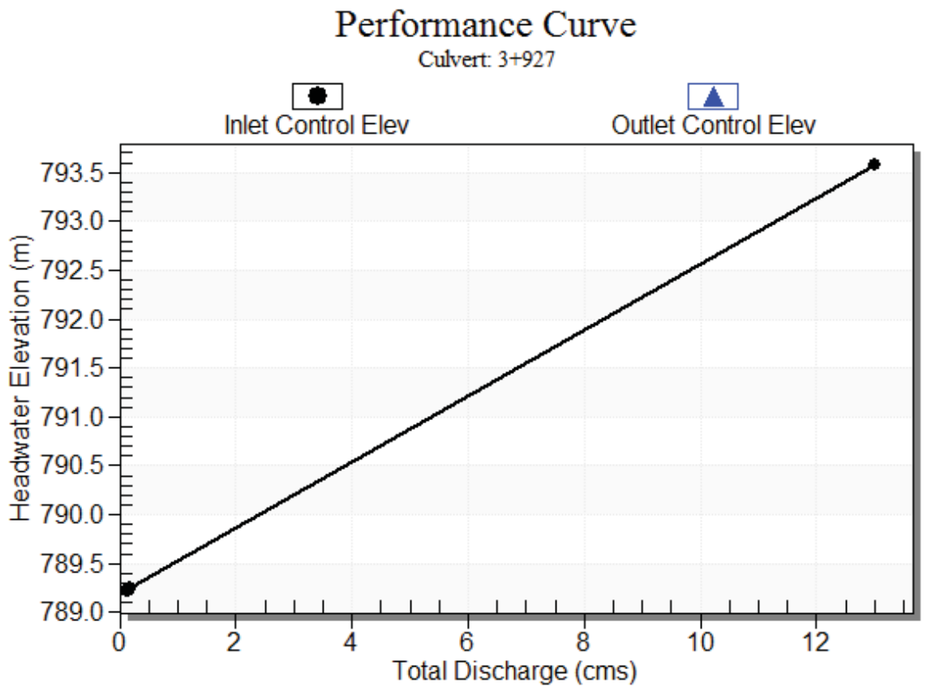
Culvert Length: 33.53 m, Culvert Slope: 0.0060

****

Water Surface Profile Plot for Culvert: 3+927



Culvert Performance Curve Plot: 3+927



HY-8 Culvert Analysis Report

Site Data - 4+726

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.26 m

Outlet Station: 27.23 m

Outlet Elevation: 788.89 m

Number of Barrels: 1

Culvert Data Summary - 4+726

Barrel Shape: Circular

Barrel Diameter: 1000.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 4+726

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.47	0.47	789.79	0.534	0.0*	1-S2n	0.289	0.384	0.300	0.141	2.276	1.929
0.48	0.48	789.80	0.543	0.062	1-S2n	0.293	0.389	0.304	0.143	2.287	1.946
0.49	0.49	789.81	0.551	0.069	1-S2n	0.297	0.394	0.307	0.145	2.306	1.963
0.50	0.50	789.82	0.559	0.076	1-S2n	0.300	0.399	0.311	0.147	2.321	1.980
0.51	0.51	789.83	0.568	0.082	1-S2n	0.304	0.403	0.315	0.149	2.336	1.997
0.52	0.52	789.84	0.576	0.089	1-S2n	0.308	0.408	0.319	0.152	2.347	2.013
0.54	0.54	789.84	0.584	0.096	1-S2n	0.311	0.413	0.323	0.154	2.358	2.029
0.55	0.55	789.85	0.592	0.103	1-S2n	0.315	0.417	0.327	0.156	2.372	2.045
0.56	0.56	789.86	0.600	0.111	1-S2n	0.318	0.422	0.330	0.158	2.386	2.060
0.57	0.57	789.87	0.607	0.118	1-S2n	0.322	0.427	0.334	0.160	2.400	2.075
0.58	0.58	789.88	0.615	0.125	1-S2n	0.325	0.432	0.338	0.162	2.414	2.090

* Full Flow Headwater elevation is below inlet invert.

****

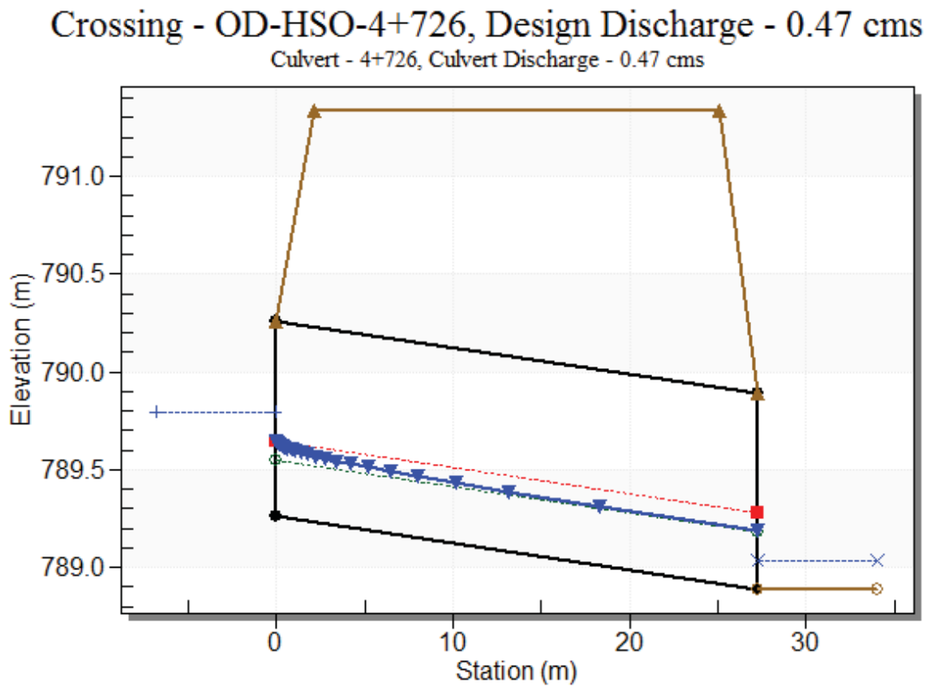
Straight Culvert

Inlet Elevation (invert): 789.26 m, Outlet Elevation (invert): 788.89 m

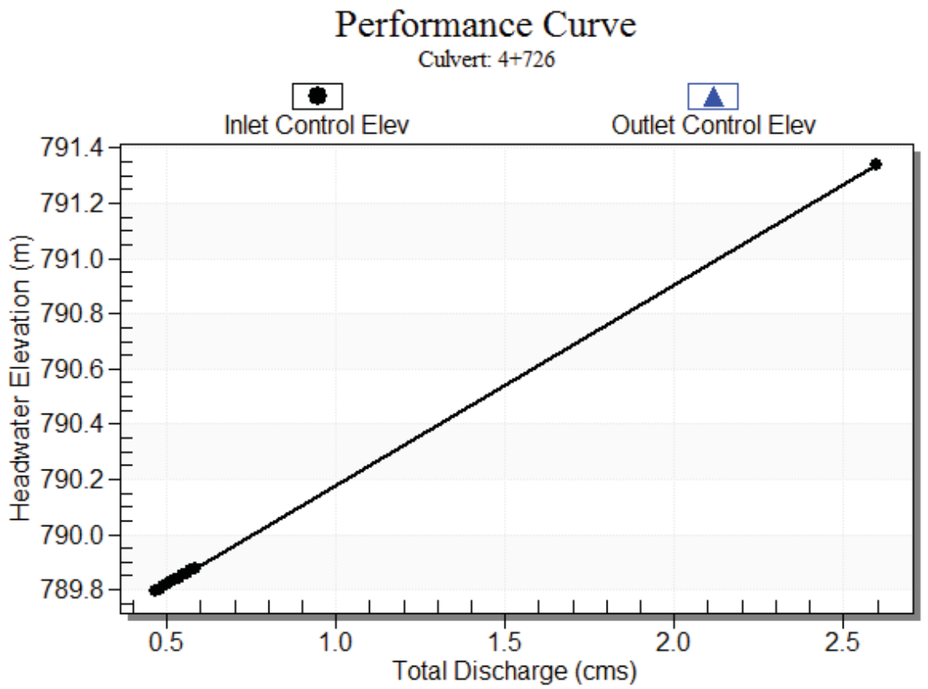
Culvert Length: 27.23 m, Culvert Slope: 0.0136

****

Water Surface Profile Plot for Culvert: 4+726



Culvert Performance Curve Plot: 4+726



HY-8 Culvert Analysis Report

Site Data - 0+868

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 784.91 m

Outlet Station: 27.82 m

Outlet Elevation: 784.69 m

Number of Barrels: 2

Culvert Data Summary - 0+868

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+868

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.45	0.45	785.36	0.450	0.0*	1-S2n	0.282	0.305	0.282	0.131	1.651	1.434
0.46	0.46	785.37	0.456	0.189	1-S2n	0.285	0.309	0.285	0.133	1.661	1.447
0.47	0.47	785.37	0.463	0.198	1-S2n	0.289	0.313	0.289	0.135	1.670	1.459
0.48	0.48	785.38	0.469	0.206	1-S2n	0.293	0.316	0.293	0.137	1.679	1.471
0.49	0.49	785.39	0.475	0.214	1-S2n	0.297	0.320	0.297	0.139	1.688	1.483
0.50	0.50	785.39	0.482	0.223	1-S2n	0.301	0.323	0.301	0.140	1.697	1.495
0.51	0.51	785.40	0.488	0.231	1-S2n	0.305	0.326	0.305	0.142	1.706	1.507
0.52	0.52	785.40	0.494	0.240	1-S2n	0.308	0.330	0.308	0.144	1.714	1.518
0.53	0.53	785.41	0.501	0.248	1-S2n	0.312	0.333	0.312	0.146	1.723	1.530
0.54	0.54	785.42	0.507	0.257	1-S2n	0.316	0.336	0.316	0.148	1.731	1.541
0.55	0.55	785.42	0.513	0.266	1-S2n	0.320	0.340	0.320	0.150	1.739	1.552

* Full Flow Headwater elevation is below inlet invert.

****

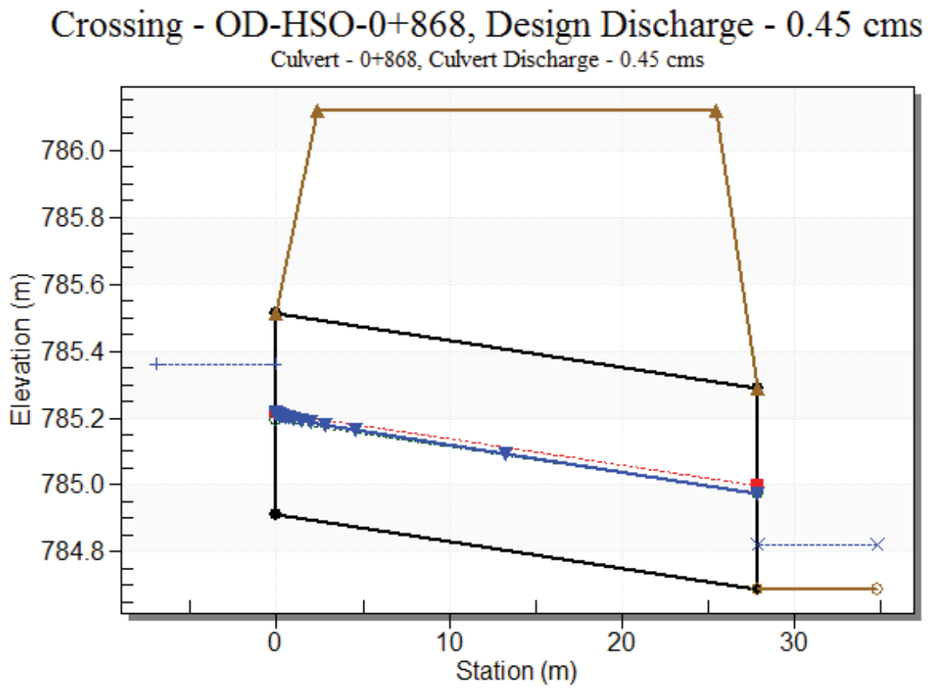
Straight Culvert

Inlet Elevation (invert): 784.91 m, Outlet Elevation (invert): 784.69 m

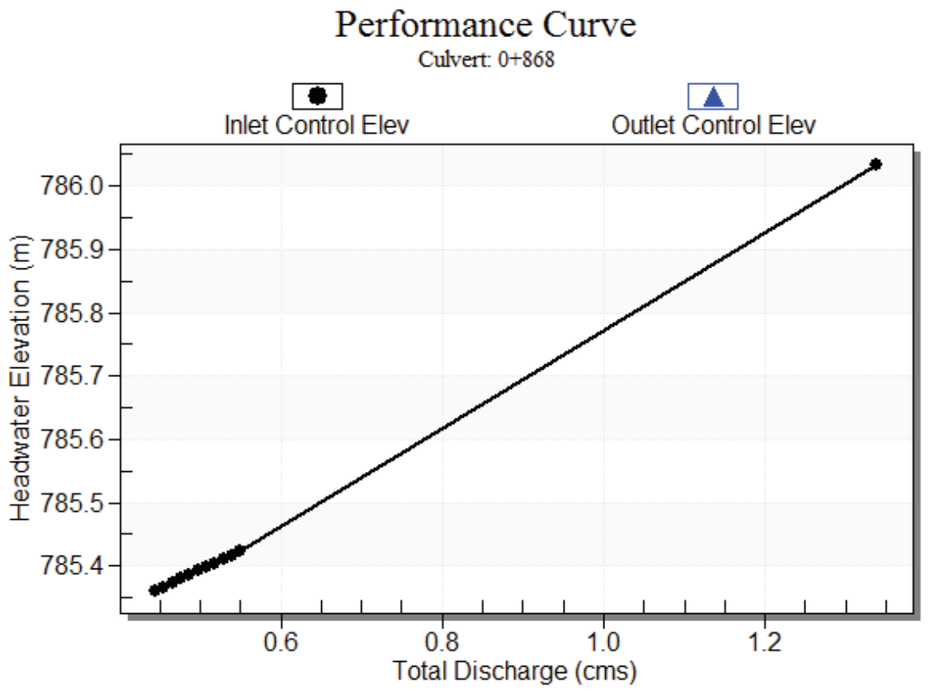
Culvert Length: 27.82 m, Culvert Slope: 0.0079

****

Water Surface Profile Plot for Culvert: 0+868



Culvert Performance Curve Plot: 0+868



HY-8 Culvert Analysis Report

Site Data - 0+120

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 780.85 m

Outlet Station: 34.19 m

Outlet Elevation: 780.10 m

Number of Barrels: 1

Culvert Data Summary - 0+120

Barrel Shape: Circular

Barrel Diameter: 1200.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+120

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.30	0.30	781.24	0.388	0.0*	1-S2n	0.192	0.287	0.192	0.081	2.442	1.866
0.30	0.30	781.24	0.393	0.0*	1-S2n	0.195	0.291	0.195	0.082	2.463	1.884
0.31	0.31	781.25	0.398	0.0*	1-S2n	0.197	0.295	0.197	0.083	2.484	1.901
0.32	0.32	781.25	0.403	0.0*	1-S2n	0.199	0.298	0.199	0.084	2.504	1.918
0.33	0.33	781.26	0.408	0.0*	1-S2n	0.201	0.302	0.201	0.085	2.503	1.935
0.33	0.33	781.26	0.412	0.0*	1-S2n	0.204	0.305	0.204	0.087	2.519	1.951
0.34	0.34	781.27	0.417	0.0*	1-S2n	0.206	0.309	0.206	0.088	2.535	1.968
0.35	0.35	781.27	0.422	0.0*	1-S2n	0.208	0.312	0.208	0.089	2.550	1.984
0.36	0.36	781.28	0.427	0.0*	1-S2n	0.210	0.316	0.210	0.090	2.565	2.000
0.36	0.36	781.28	0.432	0.0*	1-S2n	0.213	0.319	0.213	0.091	2.580	2.015
0.37	0.37	781.29	0.436	0.0*	1-S2n	0.215	0.323	0.215	0.093	2.593	2.030

* Full Flow Headwater elevation is below inlet invert.

****

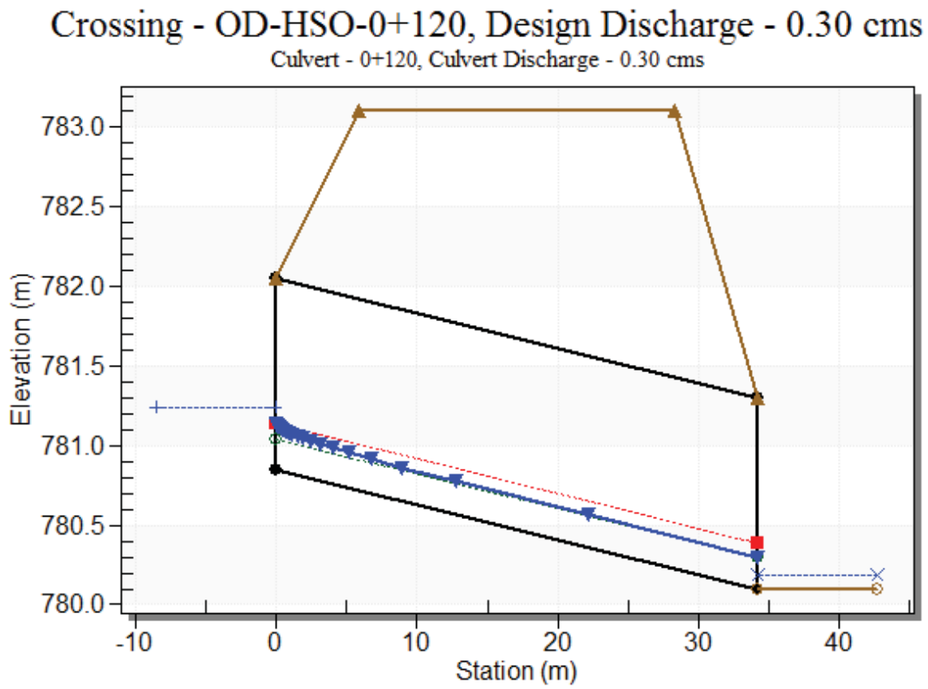
Straight Culvert

Inlet Elevation (invert): 780.85 m, Outlet Elevation (invert): 780.10 m

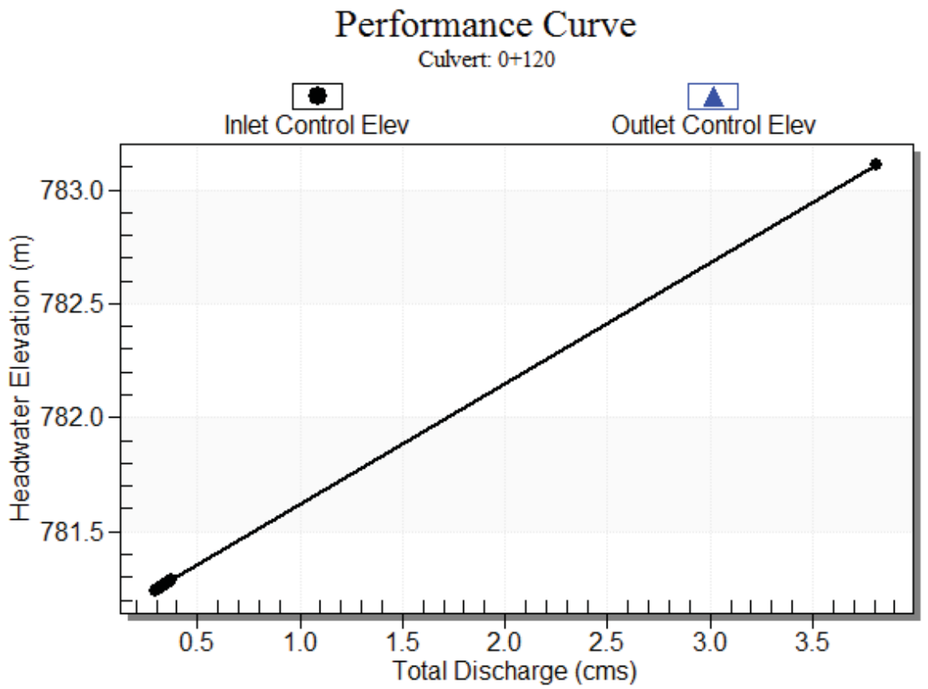
Culvert Length: 34.20 m, Culvert Slope: 0.0219

****

Water Surface Profile Plot for Culvert: 0+120



Culvert Performance Curve Plot: 0+120



APÉNDICE 2

RESULTADO CÁLCULOS CIRCUITOS INTERNOS HY-8

HY-8 Culvert Analysis Report

Site Data - 1+131

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 776.92 m

Outlet Station: 10.32 m

Outlet Elevation: 776.78 m

Number of Barrels: 1

Culvert Data Summary - 1+131

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+131

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.37	0.37	777.55	0.630	0.015	5-S2n	0.327	0.399	0.343	0.155	2.172	1.929
0.38	0.38	777.56	0.641	0.458	5-S2n	0.332	0.404	0.348	0.158	2.185	1.946
0.39	0.39	777.57	0.653	0.473	5-S2n	0.337	0.409	0.353	0.160	2.198	1.962
0.40	0.40	777.59	0.665	0.487	5-S2n	0.342	0.414	0.358	0.163	2.211	1.978
0.41	0.41	777.60	0.678	0.502	5-S2n	0.347	0.419	0.364	0.165	2.224	1.993
0.42	0.42	777.61	0.690	0.517	5-S2n	0.353	0.424	0.369	0.167	2.236	2.009
0.43	0.43	777.62	0.703	0.532	5-S2n	0.358	0.428	0.374	0.170	2.249	2.024
0.44	0.44	777.64	0.715	0.547	5-S2n	0.363	0.433	0.379	0.172	2.261	2.039
0.45	0.45	777.65	0.729	0.563	5-S2n	0.368	0.437	0.385	0.175	2.274	2.054
0.46	0.46	777.66	0.742	0.579	5-S2n	0.373	0.443	0.390	0.177	2.285	2.068
0.47	0.47	777.68	0.756	0.595	5-S2n	0.378	0.447	0.395	0.179	2.296	2.082

****

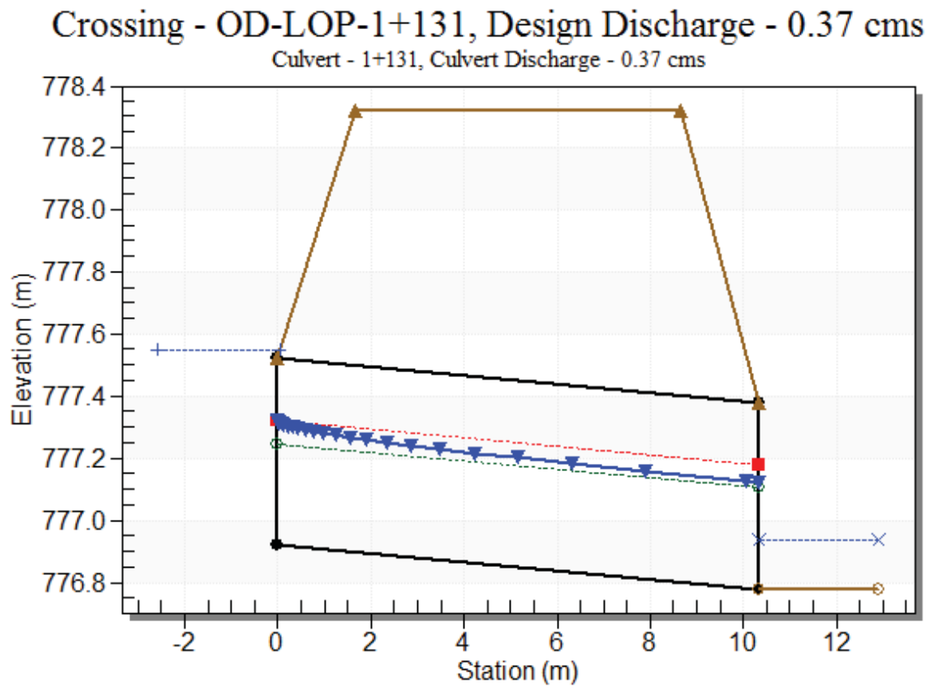
Straight Culvert

Inlet Elevation (invert): 776.92 m, Outlet Elevation (invert): 776.78 m

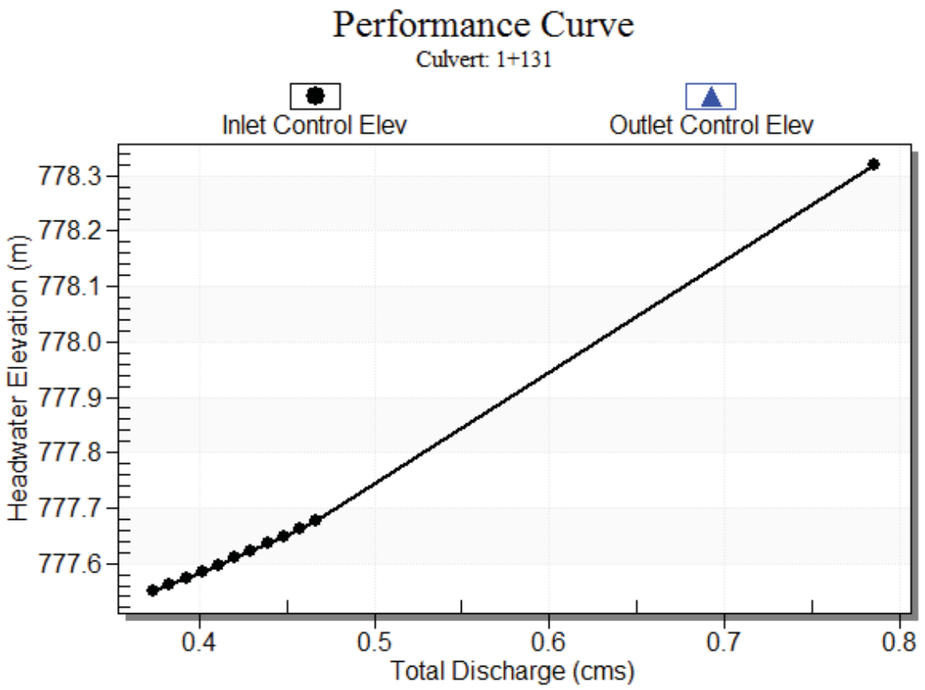
Culvert Length: 10.32 m, Culvert Slope: 0.0136

****

Water Surface Profile Plot for Culvert: 1+131



Culvert Performance Curve Plot: 1+131



HY-8 Culvert Analysis Report

Site Data - 1+220

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 777.83 m

Outlet Station: 12.32 m

Outlet Elevation: 777.77 m

Number of Barrels: 1

Culvert Data Summary - 1+220

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+220

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.02	0.02	777.97	0.129	0.143	2-M2c	0.098	0.093	0.093	0.032	0.821	0.463
0.02	0.02	777.97	0.130	0.144	2-M2c	0.099	0.094	0.094	0.032	0.825	0.467
0.02	0.02	777.98	0.131	0.146	2-M2c	0.100	0.095	0.095	0.033	0.829	0.471
0.02	0.02	777.98	0.133	0.147	2-M2c	0.101	0.096	0.096	0.033	0.833	0.474
0.02	0.02	777.98	0.134	0.149	2-M2c	0.102	0.097	0.097	0.034	0.837	0.478
0.03	0.03	777.98	0.136	0.150	2-M2c	0.103	0.099	0.099	0.034	0.841	0.482
0.03	0.03	777.98	0.137	0.152	2-M2c	0.104	0.100	0.100	0.035	0.845	0.486
0.03	0.03	777.98	0.139	0.153	2-M2c	0.105	0.101	0.101	0.035	0.849	0.489
0.03	0.03	777.98	0.140	0.155	2-M2c	0.107	0.102	0.102	0.035	0.853	0.493
0.03	0.03	777.99	0.141	0.156	2-M2c	0.108	0.103	0.103	0.036	0.856	0.496
0.03	0.03	777.99	0.143	0.158	2-M2c	0.108	0.104	0.104	0.036	0.860	0.500

****

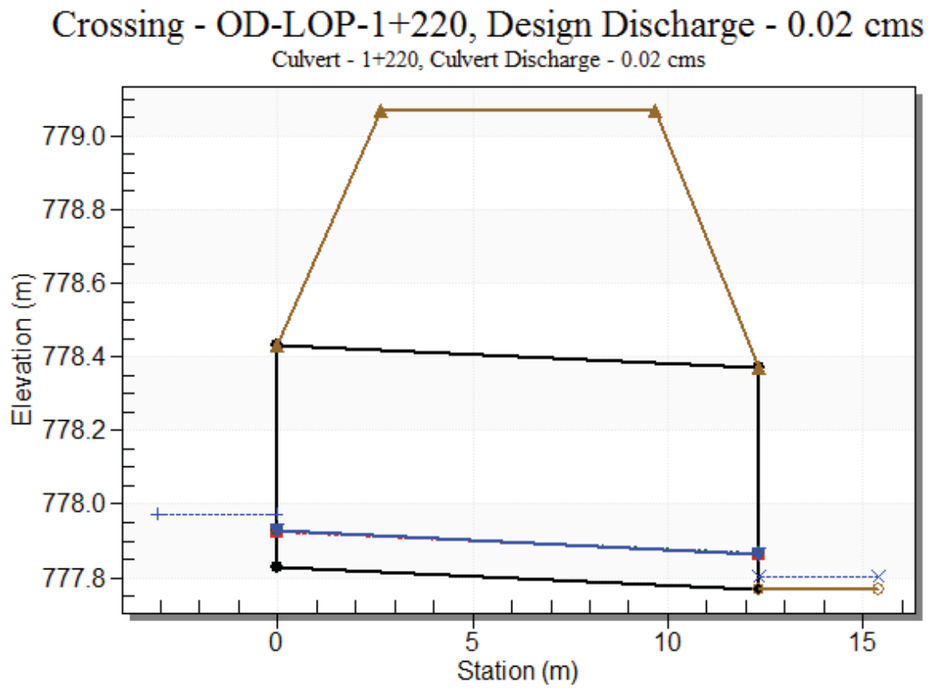
Straight Culvert

Inlet Elevation (invert): 777.83 m, Outlet Elevation (invert): 777.77 m

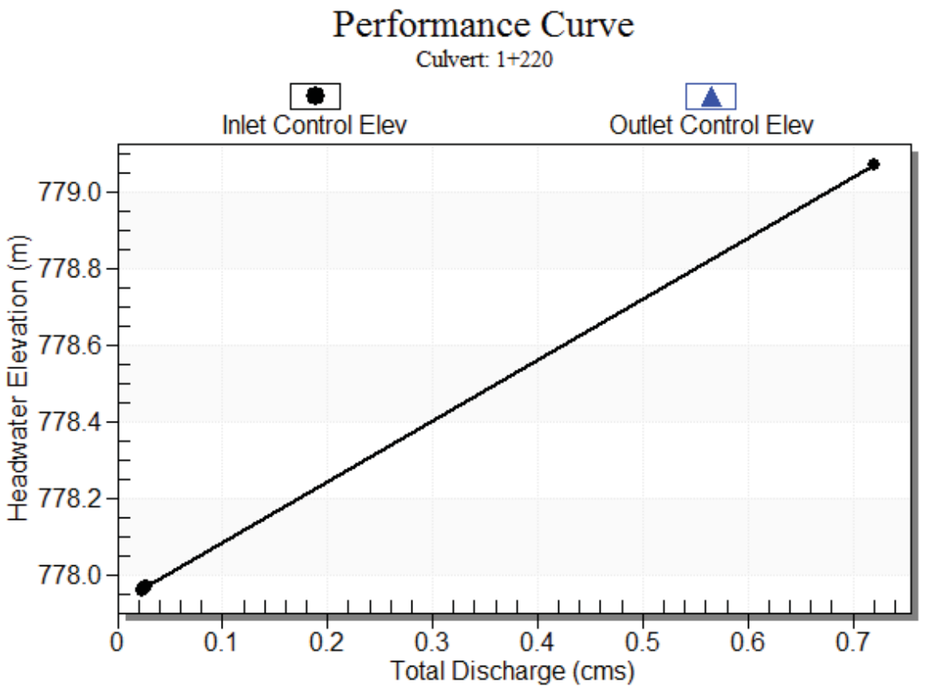
Culvert Length: 12.32 m, Culvert Slope: 0.0049

****

Water Surface Profile Plot for Culvert: 1+220



Culvert Performance Curve Plot: 1+220



HY-8 Culvert Analysis Report

Site Data - 0+000

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 791.24 m

Outlet Station: 9.25 m

Outlet Elevation: 791.15 m

Number of Barrels: 1

Culvert Data Summary - 0+000

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+000

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.03	0.03	791.39	0.145	0.0*	1-S2n	0.093	0.105	0.096	0.034	0.961	0.678
0.03	0.03	791.39	0.147	0.018	1-S2n	0.094	0.107	0.097	0.035	0.969	0.685
0.03	0.03	791.39	0.148	0.019	1-S2n	0.095	0.108	0.095	0.035	1.017	0.691
0.03	0.03	791.39	0.150	0.021	1-S2n	0.096	0.109	0.096	0.036	1.025	0.697
0.03	0.03	791.39	0.151	0.022	1-S2n	0.097	0.111	0.100	0.036	0.993	0.703
0.03	0.03	791.39	0.153	0.023	1-S2n	0.098	0.112	0.098	0.037	1.041	0.709
0.03	0.03	791.39	0.155	0.025	1-S2n	0.099	0.113	0.099	0.037	1.049	0.715
0.03	0.03	791.40	0.157	0.026	1-S2n	0.100	0.114	0.100	0.038	1.056	0.720
0.03	0.03	791.40	0.158	0.027	1-S2n	0.101	0.116	0.101	0.038	1.063	0.726
0.04	0.04	791.40	0.160	0.029	1-S2n	0.102	0.117	0.102	0.039	1.070	0.732
0.04	0.04	791.40	0.162	0.030	1-S2n	0.103	0.118	0.103	0.039	1.077	0.737

* Full Flow Headwater elevation is below inlet invert.

****

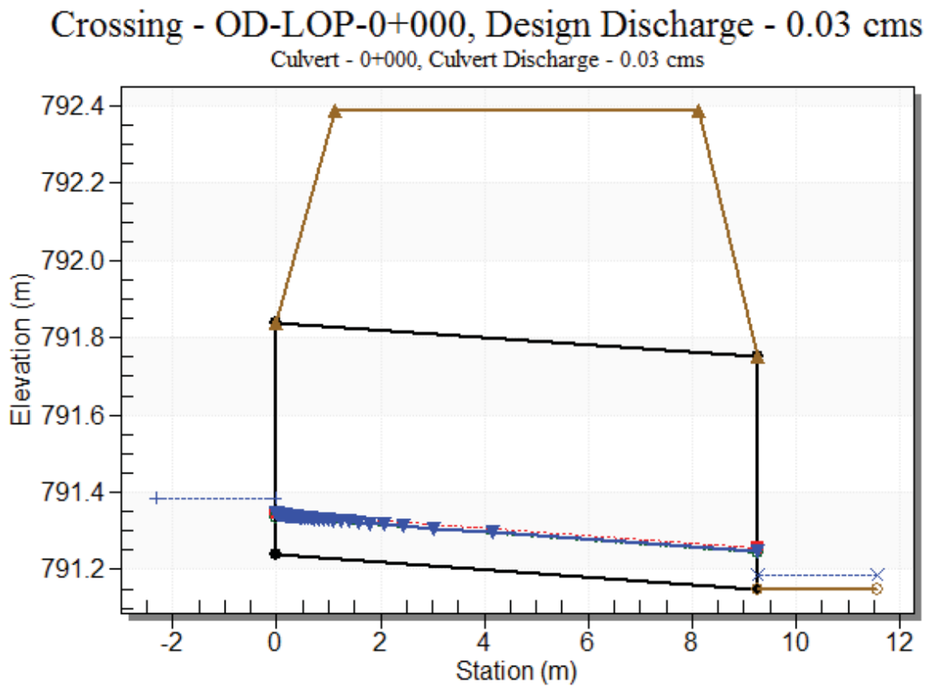
Straight Culvert

Inlet Elevation (invert): 791.24 m, Outlet Elevation (invert): 791.15 m

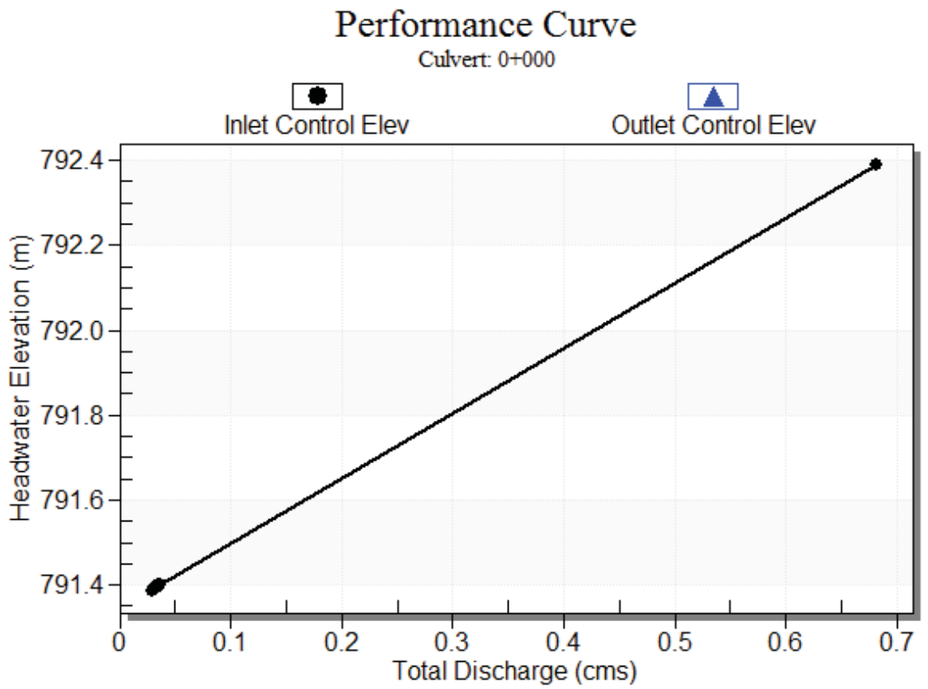
Culvert Length: 9.25 m, Culvert Slope: 0.0097

****

Water Surface Profile Plot for Culvert: 0+000



Culvert Performance Curve Plot: 0+000



HY-8 Culvert Analysis Report

Site Data - 0+370

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.67 m

Outlet Station: 10.95 m

Outlet Elevation: 788.62 m

Number of Barrels: 1

Culvert Data Summary - 0+370

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+370

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.15	0.15	789.06	0.361	0.391	2-M2c	0.268	0.252	0.252	0.106	1.373	0.968
0.16	0.16	789.07	0.366	0.396	2-M2c	0.272	0.256	0.256	0.108	1.383	0.977
0.16	0.16	789.07	0.372	0.402	2-M2c	0.275	0.259	0.259	0.109	1.392	0.985
0.17	0.17	789.08	0.377	0.407	2-M2c	0.279	0.262	0.262	0.111	1.401	0.993
0.17	0.17	789.08	0.382	0.412	2-M2c	0.283	0.265	0.265	0.113	1.411	1.001
0.17	0.17	789.09	0.388	0.417	2-M2c	0.286	0.269	0.269	0.114	1.420	1.010
0.18	0.18	789.09	0.393	0.422	2-M2c	0.290	0.272	0.272	0.116	1.430	1.018
0.18	0.18	789.10	0.398	0.427	2-M2c	0.294	0.275	0.275	0.117	1.439	1.026
0.19	0.19	789.10	0.403	0.432	2-M2c	0.297	0.278	0.278	0.119	1.448	1.033
0.19	0.19	789.11	0.408	0.437	2-M2c	0.301	0.281	0.281	0.120	1.458	1.041
0.19	0.19	789.11	0.413	0.442	2-M2c	0.304	0.284	0.284	0.122	1.467	1.049

****

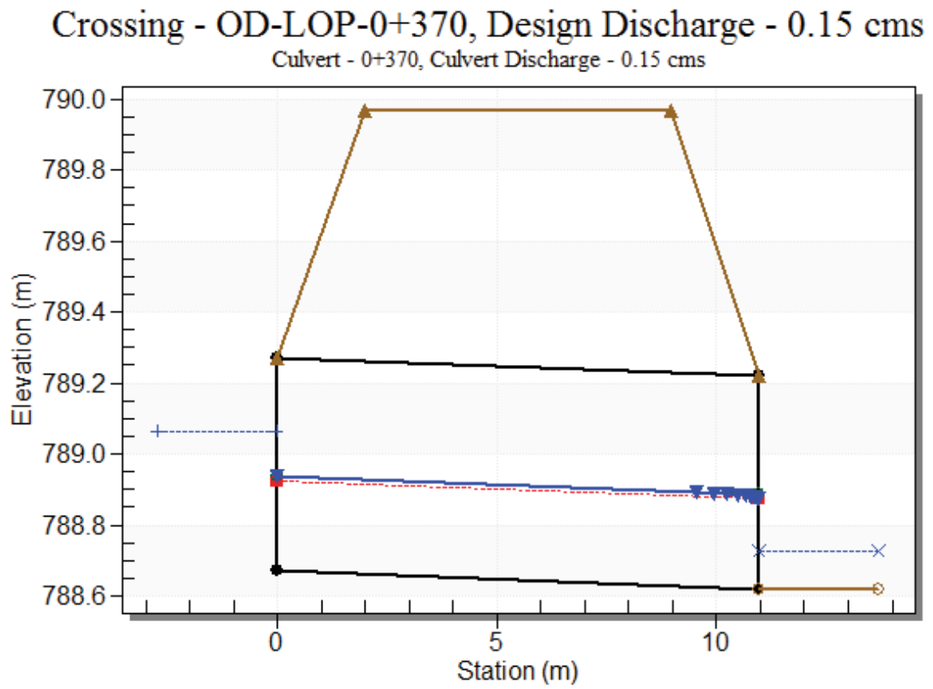
Straight Culvert

Inlet Elevation (invert): 788.67 m, Outlet Elevation (invert): 788.62 m

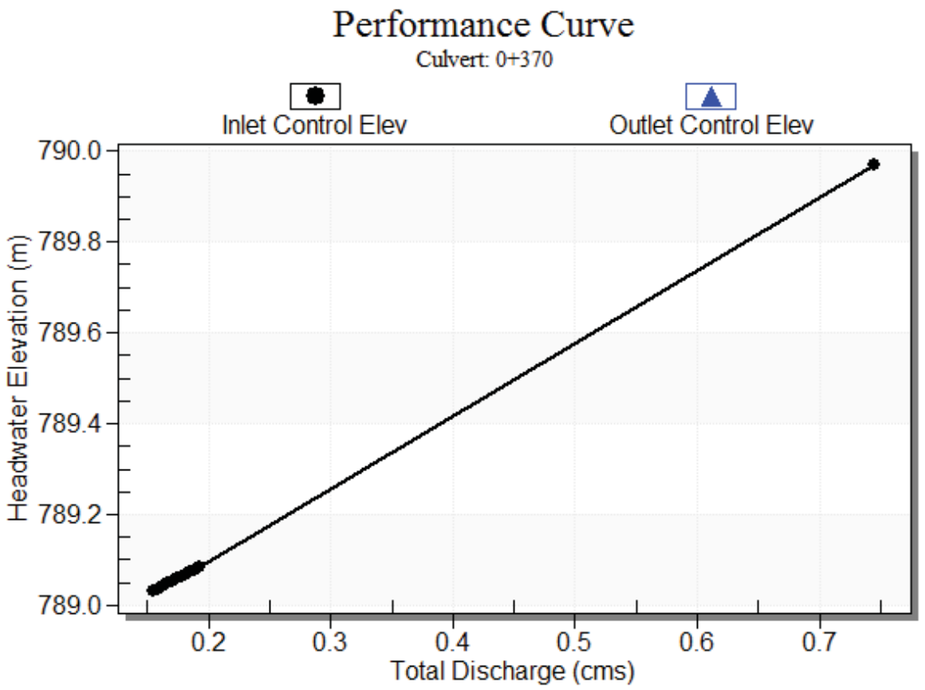
Culvert Length: 10.95 m, Culvert Slope: 0.0046

****

Water Surface Profile Plot for Culvert: 0+370



Culvert Performance Curve Plot: 0+370



HY-8 Culvert Analysis Report

Site Data - 0+490

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 785.64 m

Outlet Station: 13.39 m

Outlet Elevation: 785.48 m

Number of Barrels: 1

Culvert Data Summary - 0+490

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+490

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.21	0.21	786.07	0.428	0.0*	1-S2n	0.240	0.293	0.248	0.106	1.800	1.481
0.21	0.21	786.07	0.434	0.201	1-S2n	0.243	0.297	0.252	0.108	1.812	1.494
0.22	0.22	786.08	0.441	0.208	1-S2n	0.247	0.301	0.255	0.109	1.824	1.508
0.22	0.22	786.09	0.447	0.214	1-S2n	0.250	0.304	0.259	0.111	1.835	1.520
0.23	0.23	786.09	0.453	0.221	1-S2n	0.253	0.308	0.262	0.113	1.846	1.533
0.23	0.23	786.10	0.460	0.228	1-S2n	0.256	0.312	0.265	0.114	1.857	1.545
0.24	0.24	786.11	0.466	0.235	1-S2n	0.259	0.315	0.268	0.116	1.868	1.558
0.24	0.24	786.11	0.472	0.242	1-S2n	0.262	0.318	0.272	0.118	1.879	1.570
0.25	0.25	786.12	0.478	0.249	1-S2n	0.265	0.322	0.275	0.119	1.890	1.582
0.25	0.25	786.12	0.484	0.256	1-S2n	0.269	0.325	0.278	0.121	1.899	1.593
0.26	0.26	786.13	0.490	0.263	1-S2n	0.272	0.328	0.281	0.122	1.910	1.605

* Full Flow Headwater elevation is below inlet invert.

****

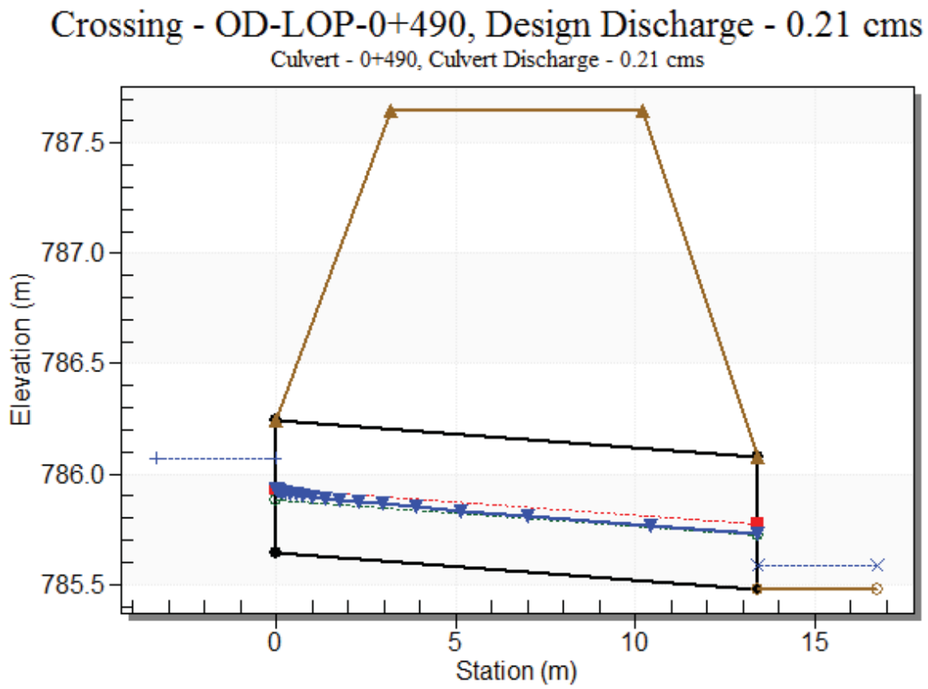
Straight Culvert

Inlet Elevation (invert): 785.64 m, Outlet Elevation (invert): 785.48 m

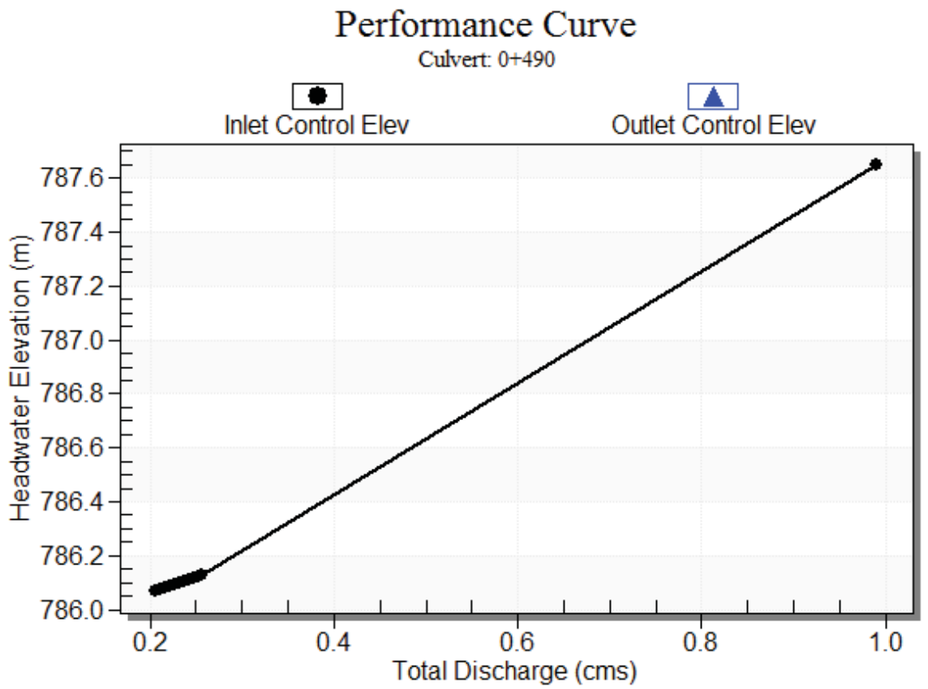
Culvert Length: 13.39 m, Culvert Slope: 0.0119

****

Water Surface Profile Plot for Culvert: 0+490



Culvert Performance Curve Plot: 0+490



HY-8 Culvert Analysis Report

Site Data - 0+740

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 781.54 m

Outlet Station: 15.24 m

Outlet Elevation: 781.36 m

Number of Barrels: 1

Culvert Data Summary - 0+740

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+740

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.29	0.29	782.07	0.531	0.0*	1-S2n	0.293	0.351	0.303	0.128	1.968	1.653
0.30	0.30	782.08	0.539	0.308	1-S2n	0.297	0.355	0.307	0.130	1.982	1.667
0.31	0.31	782.09	0.547	0.318	1-S2n	0.302	0.359	0.311	0.132	1.994	1.682
0.31	0.31	782.10	0.556	0.329	1-S2n	0.306	0.364	0.316	0.134	2.007	1.696
0.32	0.32	782.10	0.564	0.340	1-S2n	0.310	0.368	0.320	0.136	2.017	1.710
0.33	0.33	782.11	0.573	0.351	1-S2n	0.314	0.372	0.325	0.138	2.028	1.723
0.33	0.33	782.12	0.582	0.363	1-S2n	0.318	0.376	0.329	0.139	2.038	1.737
0.34	0.34	782.13	0.590	0.375	1-S2n	0.323	0.381	0.333	0.141	2.049	1.750
0.35	0.35	782.14	0.599	0.387	1-S2n	0.327	0.385	0.338	0.143	2.059	1.763
0.36	0.36	782.15	0.608	0.398	5-S2n	0.331	0.389	0.342	0.145	2.070	1.776
0.36	0.36	782.16	0.617	0.410	5-S2n	0.335	0.393	0.347	0.147	2.079	1.789

* Full Flow Headwater elevation is below inlet invert.

****

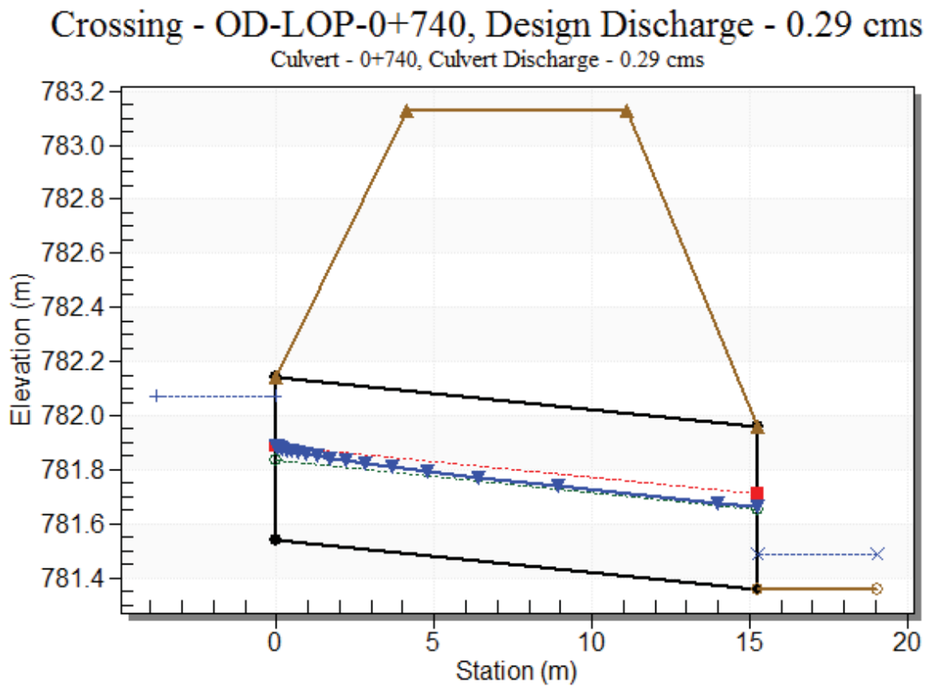
Straight Culvert

Inlet Elevation (invert): 781.54 m, Outlet Elevation (invert): 781.36 m

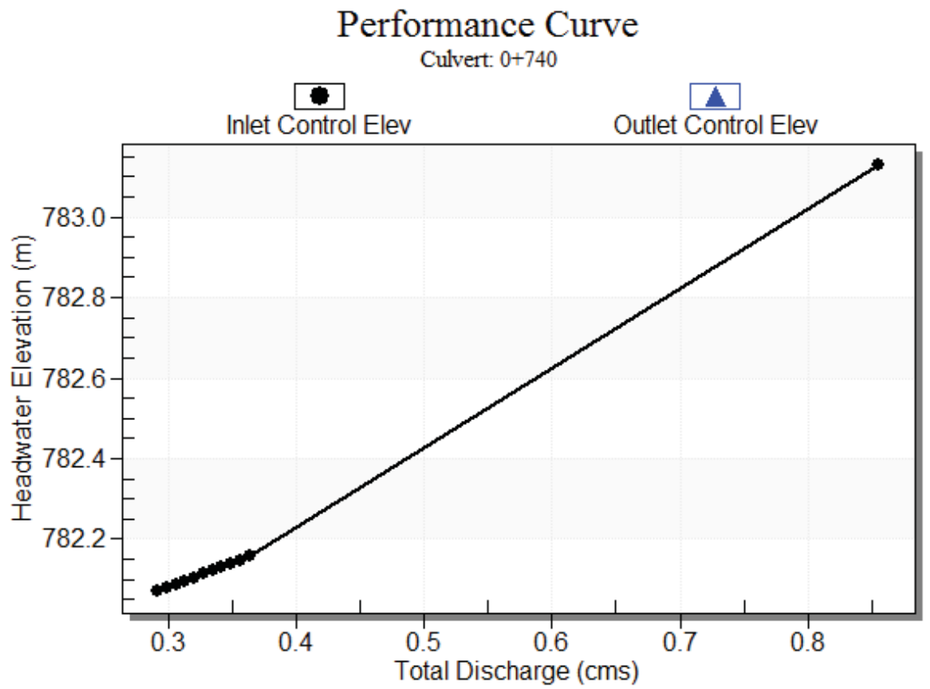
Culvert Length: 15.24 m, Culvert Slope: 0.0118

****

Water Surface Profile Plot for Culvert: 0+740



Culvert Performance Curve Plot: 0+740



HY-8 Culvert Analysis Report

Site Data - 0+950

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 778.92 m

Outlet Station: 9.28 m

Outlet Elevation: 778.88 m

Number of Barrels: 1

Culvert Data Summary - 0+950

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+950

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.16	0.16	779.32	0.368	0.397	2-M2c	0.277	0.257	0.257	0.121	1.386	1.027
0.16	0.16	779.32	0.374	0.403	2-M2c	0.281	0.260	0.260	0.123	1.396	1.036
0.17	0.17	779.33	0.379	0.408	2-M2c	0.285	0.264	0.264	0.125	1.405	1.045
0.17	0.17	779.33	0.385	0.414	2-M2c	0.289	0.267	0.267	0.126	1.415	1.054
0.18	0.18	779.34	0.391	0.419	2-M2c	0.293	0.270	0.270	0.128	1.425	1.063
0.18	0.18	779.34	0.396	0.424	2-M2c	0.297	0.273	0.273	0.130	1.435	1.072
0.18	0.18	779.35	0.401	0.429	2-M2c	0.301	0.277	0.277	0.132	1.445	1.080
0.19	0.19	779.35	0.407	0.435	2-M2c	0.305	0.280	0.280	0.134	1.455	1.088
0.19	0.19	779.36	0.412	0.440	2-M2c	0.309	0.283	0.283	0.136	1.465	1.096
0.20	0.20	779.37	0.417	0.445	2-M2c	0.313	0.286	0.286	0.138	1.474	1.104
0.20	0.20	779.37	0.422	0.450	2-M2c	0.317	0.289	0.289	0.139	1.484	1.112

****

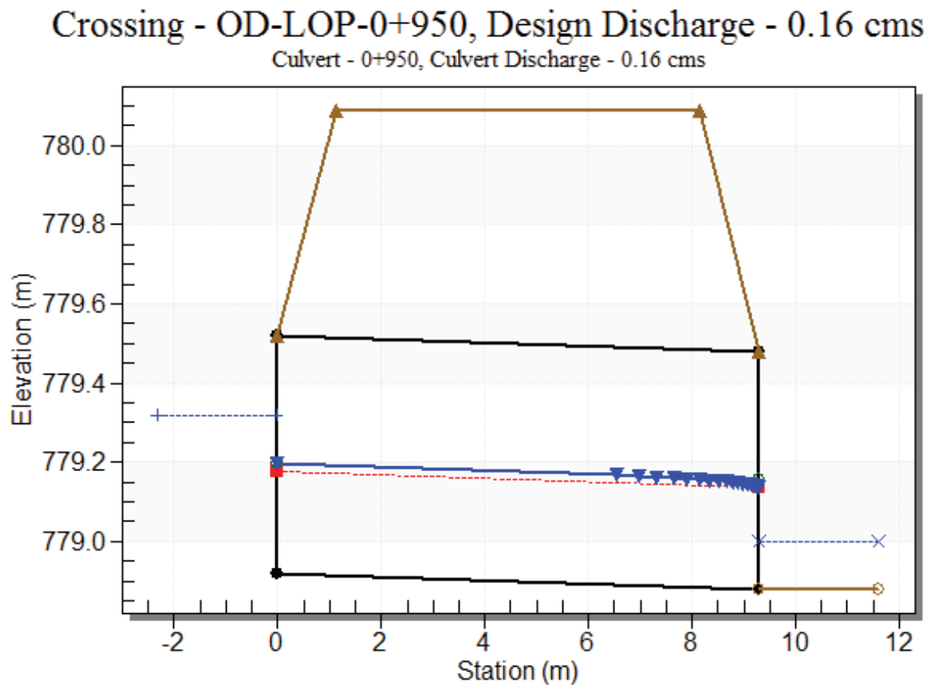
Straight Culvert

Inlet Elevation (invert): 778.92 m, Outlet Elevation (invert): 778.88 m

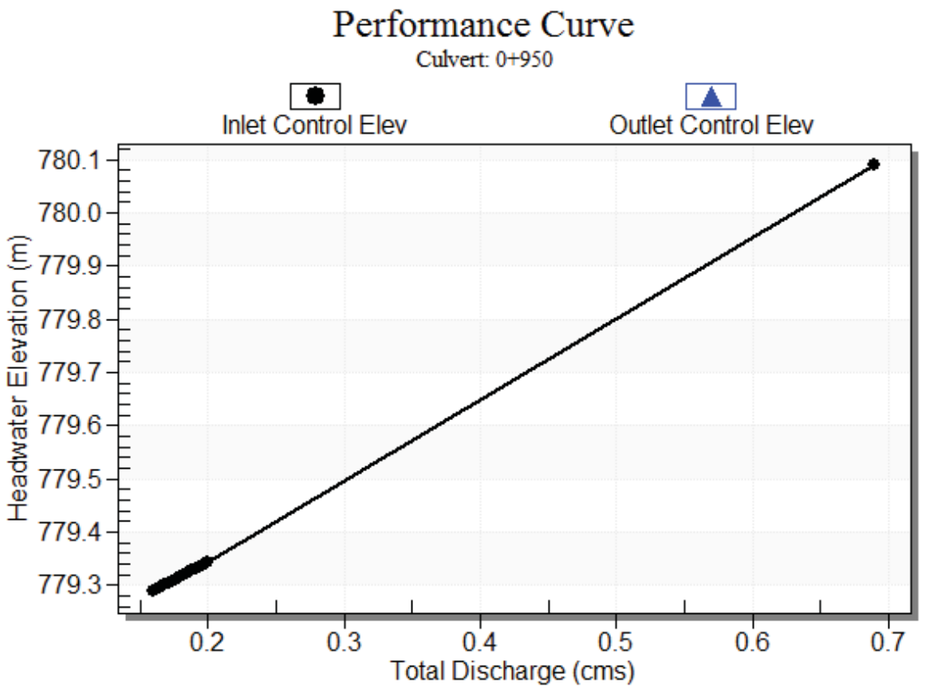
Culvert Length: 9.28 m, Culvert Slope: 0.0043

****

Water Surface Profile Plot for Culvert: 0+950



Culvert Performance Curve Plot: 0+950



HY-8 Culvert Analysis Report

Site Data - 0+575

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.35 m

Outlet Station: 22.33 m

Outlet Elevation: 789.28 m

Number of Barrels: 1

Culvert Data Summary - 0+575

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+575

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.02	0.02	789.48	0.121	0.132	2-M2c	0.102	0.087	0.087	0.029	0.796	0.434
0.02	0.02	789.48	0.122	0.134	2-M2c	0.104	0.088	0.088	0.029	0.800	0.439
0.02	0.02	789.49	0.124	0.136	2-M2c	0.105	0.089	0.089	0.030	0.805	0.442
0.02	0.02	789.49	0.125	0.137	2-M2c	0.106	0.090	0.090	0.030	0.809	0.447
0.02	0.02	789.49	0.127	0.139	2-M2c	0.107	0.091	0.091	0.031	0.813	0.451
0.02	0.02	789.49	0.127	0.140	2-M2c	0.109	0.092	0.092	0.031	0.817	0.455
0.02	0.02	789.49	0.129	0.142	2-M2c	0.110	0.093	0.093	0.032	0.821	0.458
0.02	0.02	789.49	0.130	0.144	2-M2c	0.111	0.094	0.094	0.032	0.825	0.463
0.02	0.02	789.50	0.132	0.145	2-M2c	0.112	0.095	0.095	0.032	0.829	0.466
0.02	0.02	789.50	0.133	0.147	2-M2c	0.113	0.096	0.096	0.033	0.833	0.470
0.03	0.03	789.50	0.135	0.148	2-M2c	0.114	0.097	0.097	0.033	0.837	0.474

****

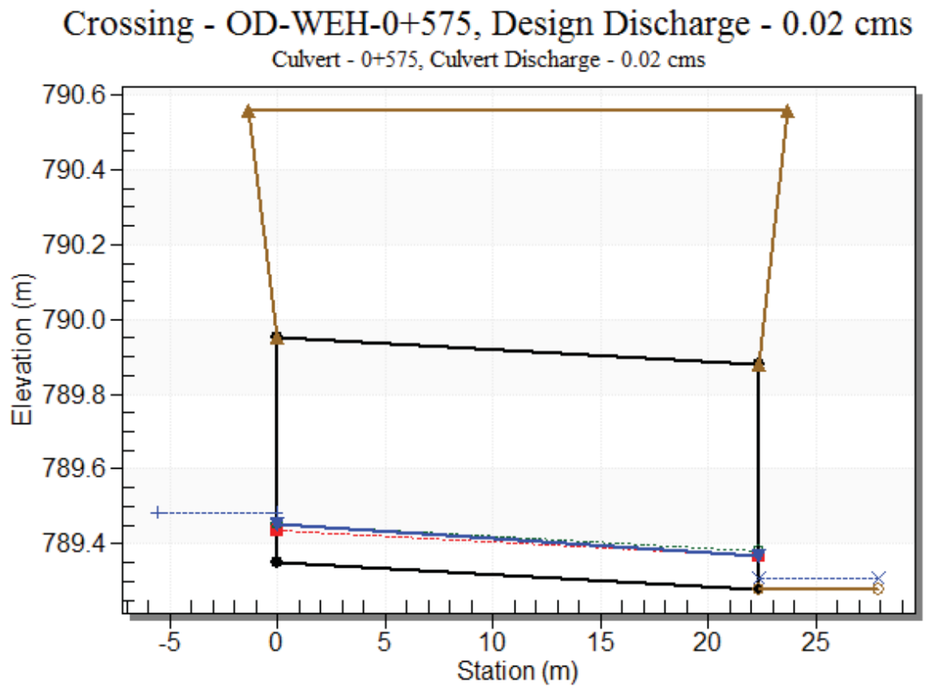
Straight Culvert

Inlet Elevation (invert): 789.35 m, Outlet Elevation (invert): 789.28 m

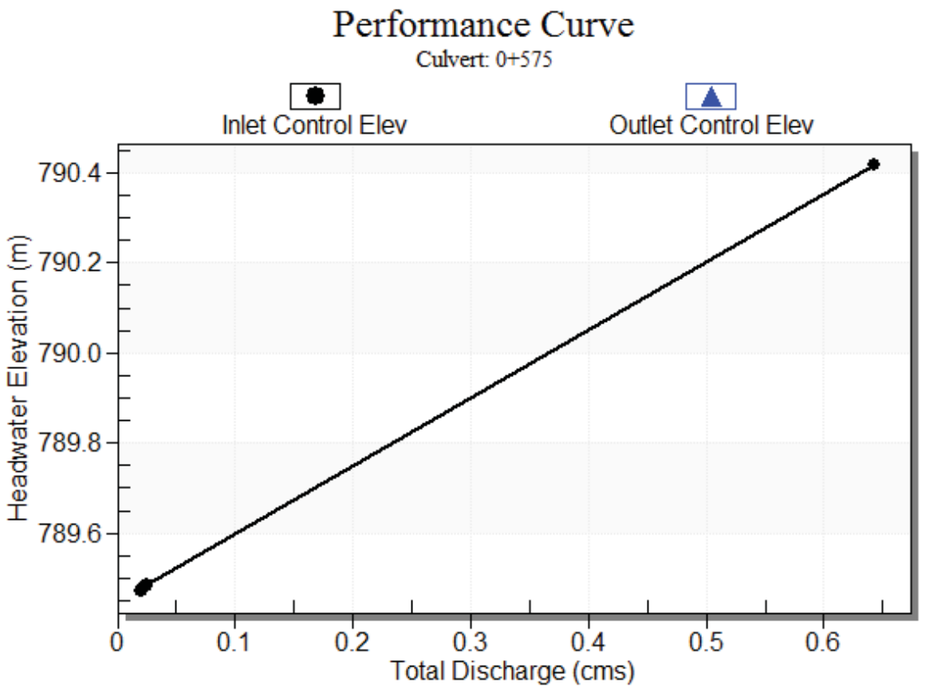
Culvert Length: 22.33 m, Culvert Slope: 0.0031

****

Water Surface Profile Plot for Culvert: 0+575



Culvert Performance Curve Plot: 0+575



HY-8 Culvert Analysis Report

Site Data - 0+735

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.33 m

Outlet Station: 33.42 m

Outlet Elevation: 787.02 m

Number of Barrels: 1

Culvert Data Summary - 0+735

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+735

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.12	0.12	788.62	0.292	0.0*	1-S2n	0.131	0.216	0.135	0.053	2.351	1.756
0.12	0.12	788.63	0.296	0.0*	1-S2n	0.132	0.219	0.137	0.054	2.371	1.772
0.12	0.12	788.63	0.299	0.0*	1-S2n	0.134	0.222	0.139	0.054	2.376	1.789
0.12	0.12	788.63	0.304	0.0*	1-S2n	0.136	0.225	0.139	0.055	2.432	1.805
0.13	0.13	788.64	0.309	0.0*	1-S2n	0.137	0.228	0.137	0.056	2.540	1.821
0.13	0.13	788.64	0.313	0.0*	1-S2n	0.139	0.230	0.139	0.057	2.540	1.837
0.13	0.13	788.65	0.318	0.0*	1-S2n	0.140	0.232	0.145	0.058	2.447	1.852
0.14	0.14	788.65	0.322	0.0*	1-S2n	0.142	0.235	0.147	0.058	2.460	1.867
0.14	0.14	788.66	0.327	0.0*	1-S2n	0.143	0.238	0.148	0.059	2.474	1.883
0.14	0.14	788.66	0.331	0.0*	1-S2n	0.145	0.241	0.150	0.060	2.490	1.897
0.15	0.15	788.67	0.336	0.0*	1-S2n	0.146	0.243	0.151	0.061	2.505	1.912

* Full Flow Headwater elevation is below inlet invert.

****

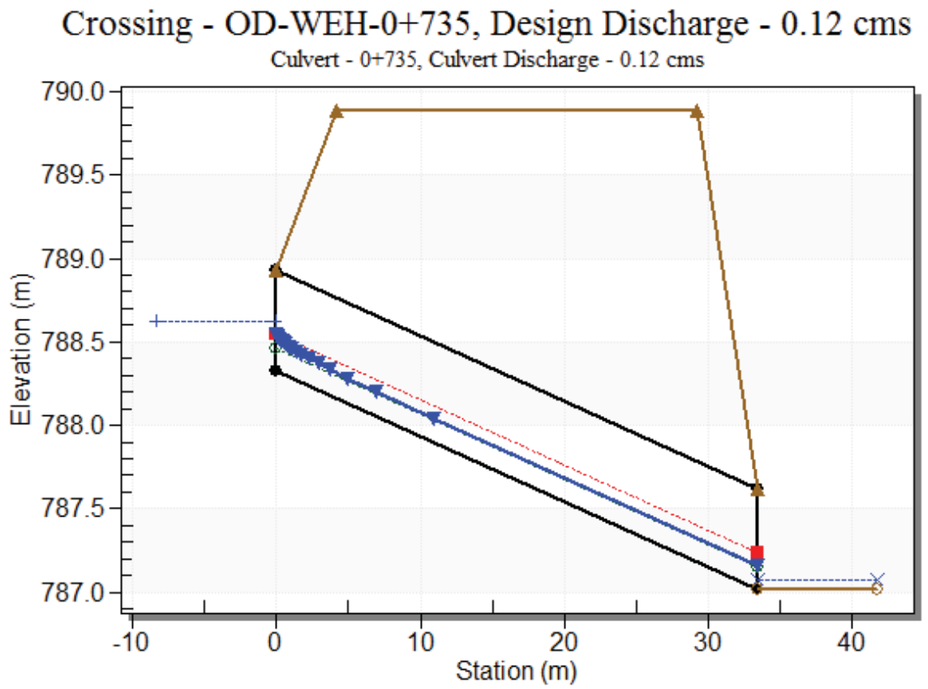
Straight Culvert

Inlet Elevation (invert): 788.33 m, Outlet Elevation (invert): 787.02 m

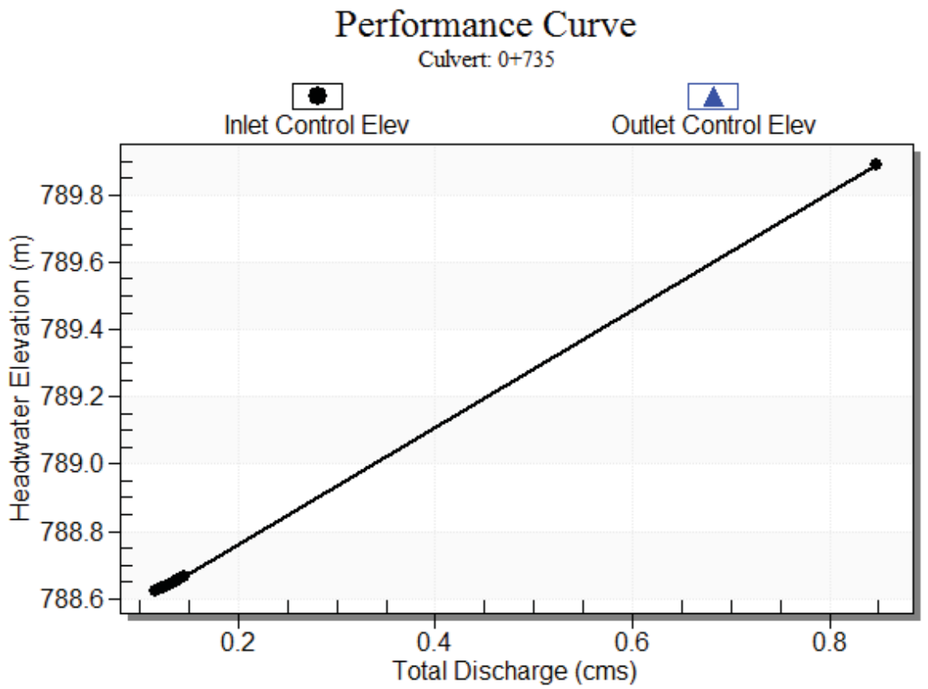
Culvert Length: 33.45 m, Culvert Slope: 0.0392

****

Water Surface Profile Plot for Culvert: 0+735



Culvert Performance Curve Plot: 0+735



HY-8 Culvert Analysis Report

Site Data - 1+348

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.95 m

Outlet Station: 27.27 m

Outlet Elevation: 788.73 m

Number of Barrels: 1

Culvert Data Summary - 1+348

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+348

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.13	0.13	789.27	0.322	0.0*	1-S2n	0.208	0.229	0.208	0.093	1.443	1.117
0.13	0.13	789.28	0.327	0.046	1-S2n	0.211	0.232	0.211	0.095	1.453	1.127
0.14	0.14	789.28	0.332	0.051	1-S2n	0.214	0.235	0.214	0.096	1.463	1.137
0.14	0.14	789.29	0.337	0.056	1-S2n	0.216	0.239	0.216	0.098	1.470	1.147
0.14	0.14	789.29	0.342	0.061	1-S2n	0.219	0.242	0.219	0.099	1.480	1.157
0.15	0.15	789.30	0.347	0.066	1-S2n	0.222	0.245	0.222	0.100	1.490	1.167
0.15	0.15	789.30	0.352	0.071	1-S2n	0.224	0.248	0.224	0.102	1.499	1.176
0.15	0.15	789.31	0.357	0.075	1-S2n	0.227	0.251	0.227	0.103	1.508	1.186
0.16	0.16	789.31	0.362	0.080	1-S2n	0.230	0.254	0.230	0.105	1.517	1.195
0.16	0.16	789.32	0.367	0.085	1-S2n	0.232	0.256	0.232	0.106	1.524	1.204
0.16	0.16	789.32	0.371	0.090	1-S2n	0.235	0.259	0.235	0.108	1.533	1.213

* Full Flow Headwater elevation is below inlet invert.

****

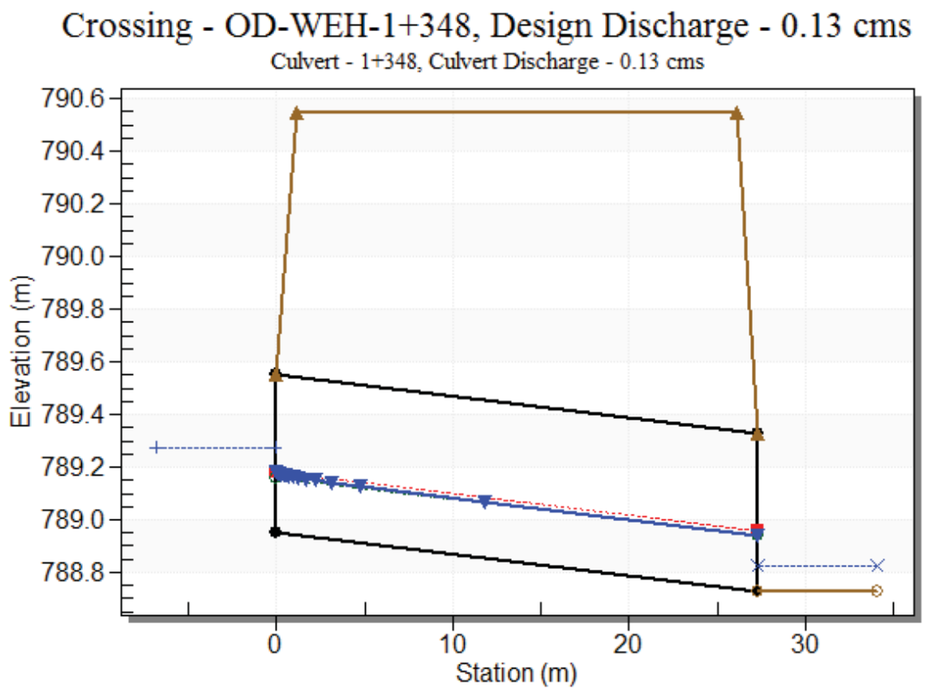
Straight Culvert

Inlet Elevation (invert): 788.95 m, Outlet Elevation (invert): 788.73 m

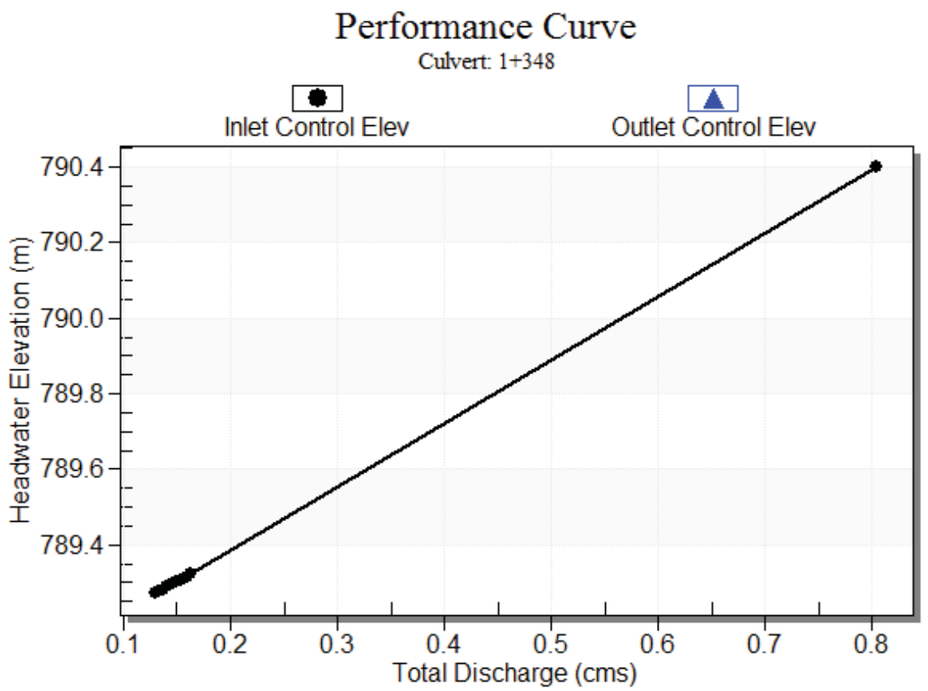
Culvert Length: 27.27 m, Culvert Slope: 0.0081

****

Water Surface Profile Plot for Culvert: 1+348



Culvert Performance Curve Plot: 1+348



HY-8 Culvert Analysis Report

Site Data - 0+328

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.71 m

Outlet Station: 27.80 m

Outlet Elevation: 789.57 m

Number of Barrels: 1

Culvert Data Summary - 0+328

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+328

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.06	0.06	789.94	0.204	0.228	2-M2c	0.152	0.148	0.148	0.062	1.035	0.693
0.06	0.06	789.94	0.207	0.231	2-M2c	0.154	0.150	0.150	0.063	1.042	0.699
0.06	0.06	789.94	0.210	0.234	2-M2c	0.156	0.152	0.152	0.064	1.048	0.706
0.06	0.06	789.95	0.212	0.237	2-M2c	0.158	0.154	0.154	0.065	1.054	0.712
0.06	0.06	789.95	0.214	0.239	2-M2c	0.159	0.155	0.155	0.065	1.060	0.718
0.06	0.06	789.95	0.217	0.242	2-M2c	0.161	0.157	0.157	0.066	1.066	0.725
0.06	0.06	789.96	0.219	0.245	2-M2c	0.163	0.159	0.159	0.067	1.072	0.730
0.07	0.07	789.96	0.222	0.248	2-M2c	0.165	0.161	0.161	0.068	1.078	0.737
0.07	0.07	789.96	0.224	0.251	2-M2c	0.167	0.163	0.163	0.069	1.084	0.742
0.07	0.07	789.96	0.227	0.253	2-M2c	0.169	0.165	0.165	0.070	1.090	0.748
0.07	0.07	789.97	0.229	0.256	2-M2c	0.170	0.166	0.166	0.071	1.095	0.754

****

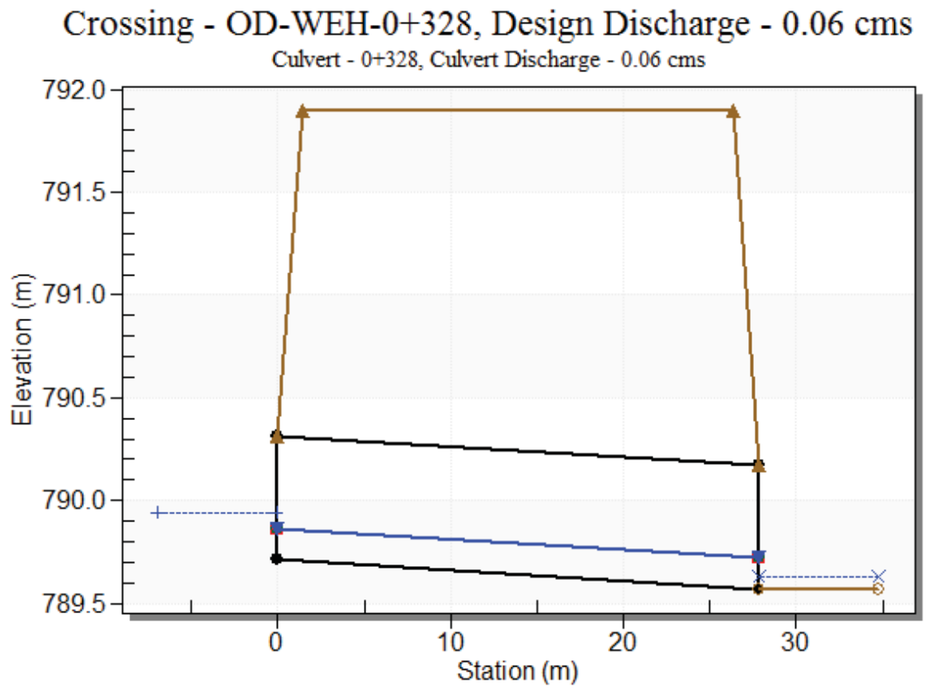
Straight Culvert

Inlet Elevation (invert): 789.71 m, Outlet Elevation (invert): 789.57 m

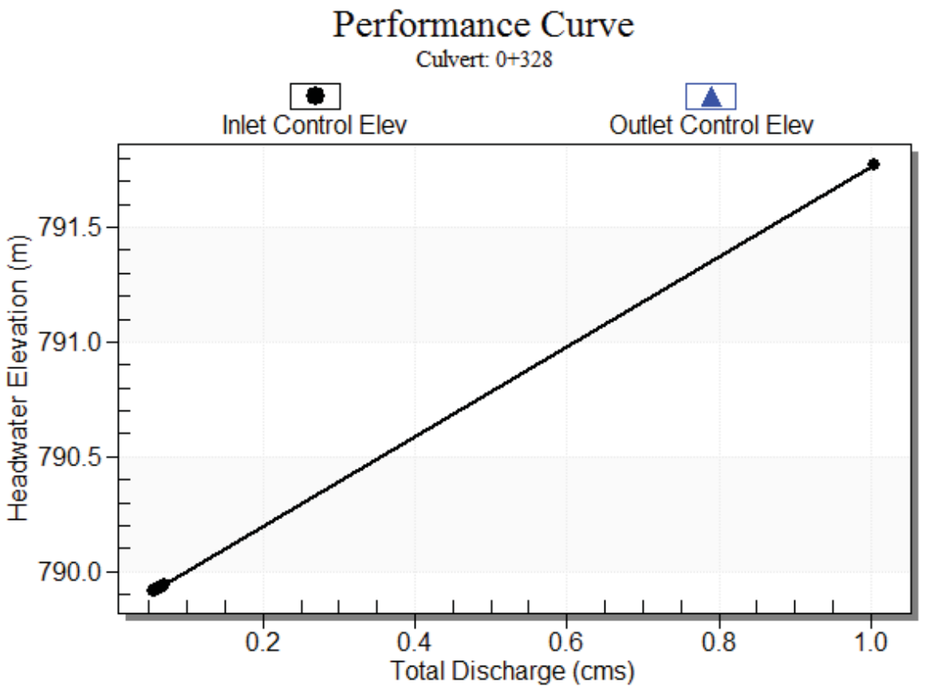
Culvert Length: 27.80 m, Culvert Slope: 0.0050

****

Water Surface Profile Plot for Culvert: 0+328



Culvert Performance Curve Plot: 0+328



HY-8 Culvert Analysis Report

Site Data - 1+278

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.72 m

Outlet Station: 28.89 m

Outlet Elevation: 789.34 m

Number of Barrels: 1

Culvert Data Summary - 1+278

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+278

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.07	0.07	789.95	0.228	0.0*	1-S2n	0.133	0.166	0.133	0.062	1.447	0.877
0.07	0.07	789.95	0.231	0.0*	1-S2n	0.135	0.168	0.135	0.063	1.458	0.885
0.07	0.07	789.95	0.233	0.0*	1-S2n	0.137	0.171	0.137	0.064	1.469	0.893
0.08	0.08	789.96	0.236	0.0*	1-S2n	0.138	0.173	0.138	0.065	1.468	0.901
0.08	0.08	789.96	0.239	0.0*	1-S2n	0.140	0.175	0.140	0.066	1.479	0.908
0.08	0.08	789.96	0.242	0.0*	1-S2n	0.141	0.177	0.141	0.066	1.490	0.916
0.08	0.08	789.96	0.245	0.0*	1-S2n	0.143	0.179	0.143	0.067	1.500	0.924
0.08	0.08	789.97	0.248	0.0*	1-S2n	0.144	0.181	0.144	0.068	1.510	0.931
0.08	0.08	789.97	0.250	0.0*	1-S2n	0.146	0.183	0.146	0.069	1.520	0.938
0.09	0.09	789.97	0.253	0.0*	1-S2n	0.147	0.185	0.147	0.070	1.530	0.945
0.09	0.09	789.98	0.255	0.0*	1-S2n	0.149	0.187	0.149	0.071	1.539	0.952

* Full Flow Headwater elevation is below inlet invert.

****

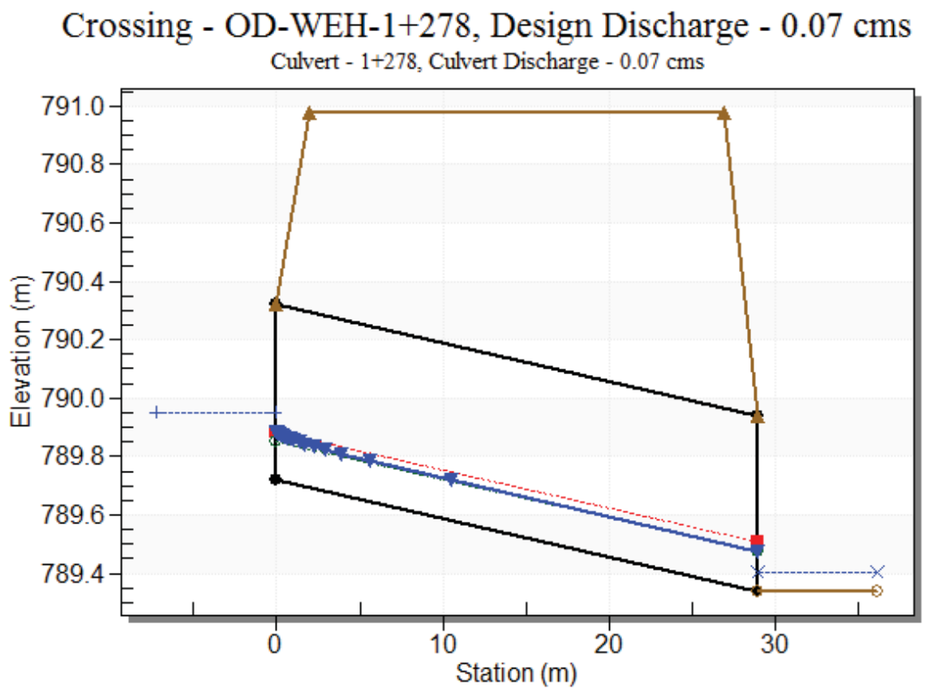
Straight Culvert

Inlet Elevation (invert): 789.72 m, Outlet Elevation (invert): 789.34 m

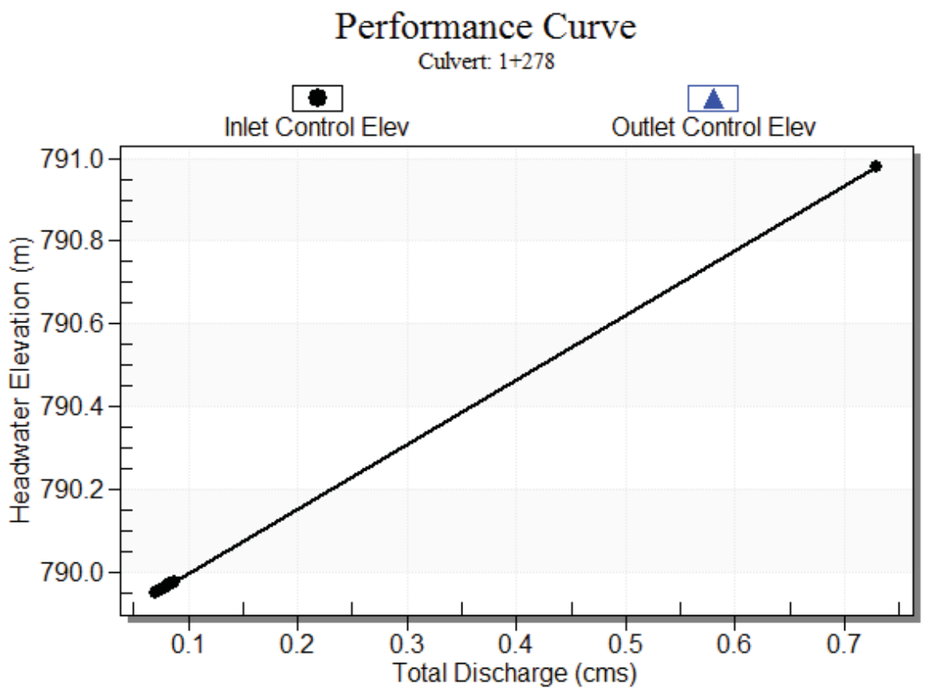
Culvert Length: 28.89 m, Culvert Slope: 0.0132

****

Water Surface Profile Plot for Culvert: 1+278



Culvert Performance Curve Plot: 1+278



HY-8 Culvert Analysis Report

Site Data - 0+360

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 786.53 m

Outlet Station: 38.24 m

Outlet Elevation: 785.95 m

Number of Barrels: 1

Culvert Data Summary - 0+360

Barrel Shape: Circular

Barrel Diameter: 1200.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+360

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.59	0.59	787.09	0.562	0.0*	1-S2n	0.297	0.411	0.297	0.208	2.610	1.455
0.60	0.60	787.10	0.569	0.0*	1-S2n	0.300	0.416	0.310	0.211	2.510	1.467
0.62	0.62	787.11	0.576	0.0*	1-S2n	0.304	0.421	0.314	0.214	2.528	1.479
0.63	0.63	787.11	0.583	0.0*	1-S2n	0.308	0.426	0.318	0.217	2.545	1.491
0.65	0.65	787.12	0.590	0.0*	1-S2n	0.311	0.431	0.321	0.221	2.560	1.502
0.66	0.66	787.13	0.597	0.0*	1-S2n	0.314	0.436	0.325	0.224	2.569	1.513
0.67	0.67	787.13	0.604	0.0*	1-S2n	0.318	0.440	0.329	0.227	2.583	1.525
0.69	0.69	787.14	0.612	0.0*	1-S2n	0.321	0.444	0.332	0.230	2.596	1.536
0.70	0.70	787.15	0.621	0.0*	1-S2n	0.324	0.449	0.336	0.233	2.610	1.547
0.72	0.72	787.16	0.628	0.0*	1-S2n	0.328	0.454	0.340	0.236	2.622	1.557
0.73	0.73	787.17	0.636	0.0*	1-S2n	0.331	0.458	0.331	0.239	2.773	1.568

* Full Flow Headwater elevation is below inlet invert.

****

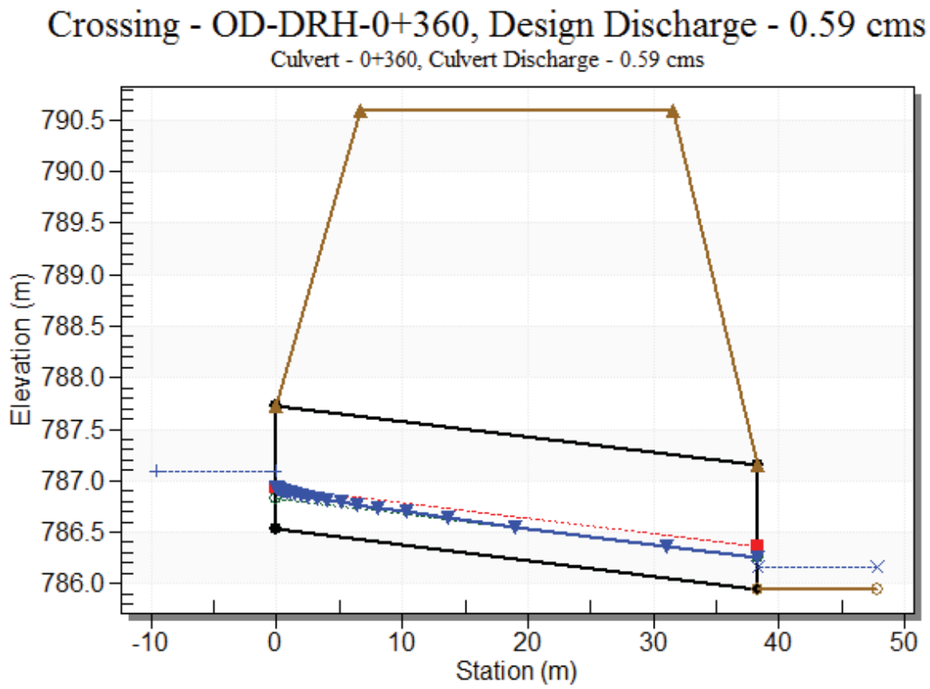
Straight Culvert

Inlet Elevation (invert): 786.53 m, Outlet Elevation (invert): 785.95 m

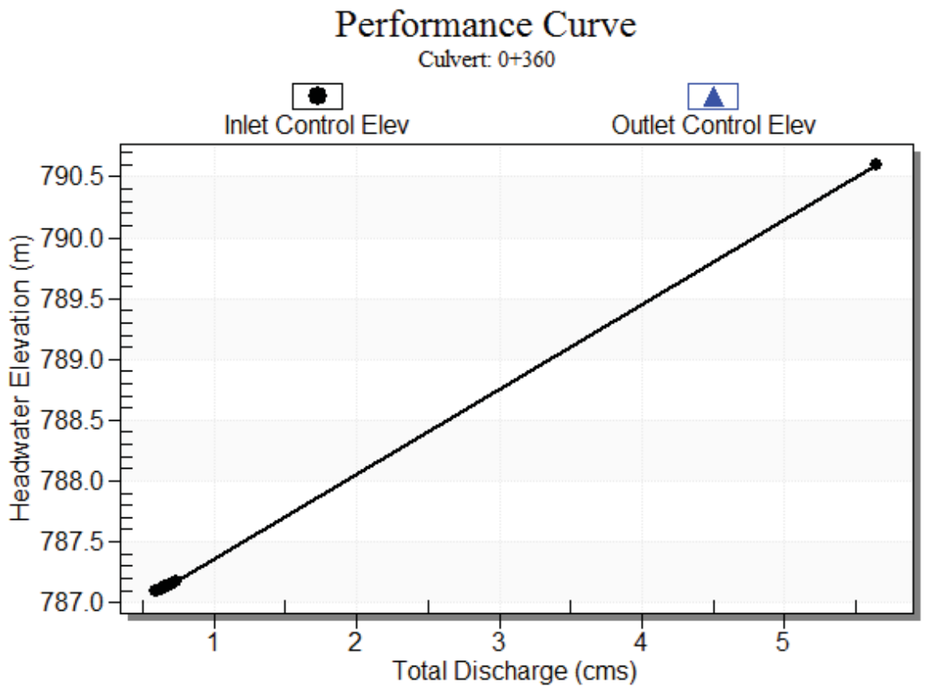
Culvert Length: 38.24 m, Culvert Slope: 0.0152

****

Water Surface Profile Plot for Culvert: 0+360



Culvert Performance Curve Plot: 0+360



HY-8 Culvert Analysis Report

Site Data - 1+200

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.38 m

Outlet Station: 30.65 m

Outlet Elevation: 788.22 m

Number of Barrels: 1

Culvert Data Summary - 1+200

Barrel Shape: Circular

Barrel Diameter: 1000.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+200

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.29	0.29	788.79	0.412	0.156	1-S2n	0.290	0.299	0.290	0.144	1.482	1.169
79.08	6.86	799.55	11.169	20.327	4-FFf	1.000	1.000	1.000	11.324	8.740	4.060
157.88	9.73	810.31	21.933	40.332	4-FFf	1.000	1.000	1.000	22.085	12.387	4.156
236.67	11.92	821.07	32.685	60.317	4-FFf	1.000	1.000	1.000	32.836	15.180	4.190
315.46	13.77	831.81	43.435	80.298	4-FFf	1.000	1.000	1.000	43.584	17.533	4.208
394.25	15.40	842.56	54.183	100.275	4-FFf	1.000	1.000	1.000	54.331	19.605	4.219
473.05	16.87	853.31	64.930	120.252	4-FFf	1.000	1.000	1.000	65.077	21.478	4.226
551.84	18.22	864.06	75.677	140.228	4-FFf	1.000	1.000	1.000	75.823	23.200	4.231
630.63	19.48	874.80	86.424	160.203	4-FFf	1.000	1.000	1.000	86.569	24.803	4.235
709.43	20.66	885.55	97.171	180.178	4-FFf	1.000	1.000	1.000	97.314	26.308	4.238
788.22	21.78	896.30	107.917	200.153	4-FFf	1.000	1.000	1.000	108.060	27.732	4.241

****

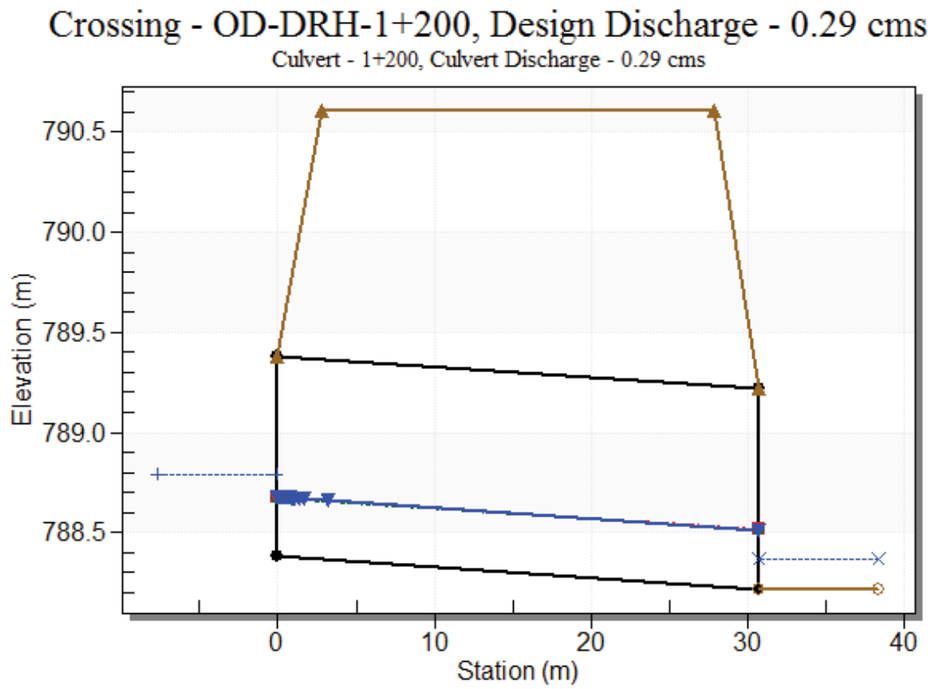
Straight Culvert

Inlet Elevation (invert): 788.38 m, Outlet Elevation (invert): 788.22 m

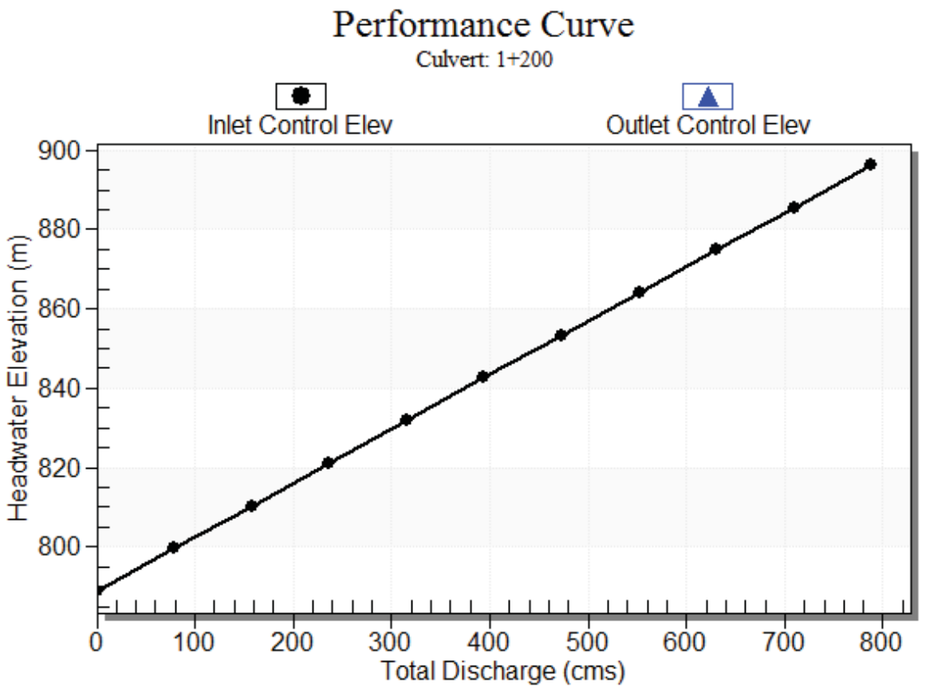
Culvert Length: 30.65 m, Culvert Slope: 0.0052

****

Water Surface Profile Plot for Culvert: 1+200



Culvert Performance Curve Plot: 1+200



HY-8 Culvert Analysis Report

Site Data - 3+105

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.44 m

Outlet Station: 33.12 m

Outlet Elevation: 788.30 m

Number of Barrels: 1

Culvert Data Summary - 3+105

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 3+105

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.02	0.02	788.57	0.120	0.132	2-M2c	0.095	0.087	0.087	0.034	0.796	0.475
0.02	0.02	788.57	0.122	0.134	2-M2c	0.096	0.088	0.088	0.034	0.800	0.479
0.02	0.02	788.58	0.124	0.135	2-M2c	0.097	0.089	0.089	0.035	0.805	0.484
0.02	0.02	788.58	0.125	0.137	2-M2c	0.098	0.090	0.090	0.035	0.809	0.489
0.02	0.02	788.58	0.127	0.139	2-M2c	0.100	0.091	0.091	0.036	0.813	0.493
0.02	0.02	788.58	0.127	0.140	2-M2c	0.101	0.092	0.092	0.036	0.817	0.497
0.02	0.02	788.58	0.129	0.142	2-M2c	0.102	0.093	0.093	0.037	0.821	0.501
0.02	0.02	788.58	0.130	0.143	2-M2c	0.103	0.094	0.094	0.037	0.825	0.505
0.02	0.02	788.59	0.132	0.145	2-M2c	0.104	0.095	0.095	0.038	0.829	0.510
0.02	0.02	788.59	0.133	0.147	2-M2c	0.105	0.096	0.096	0.038	0.833	0.514
0.03	0.03	788.59	0.134	0.148	2-M2c	0.106	0.097	0.097	0.039	0.837	0.517

****

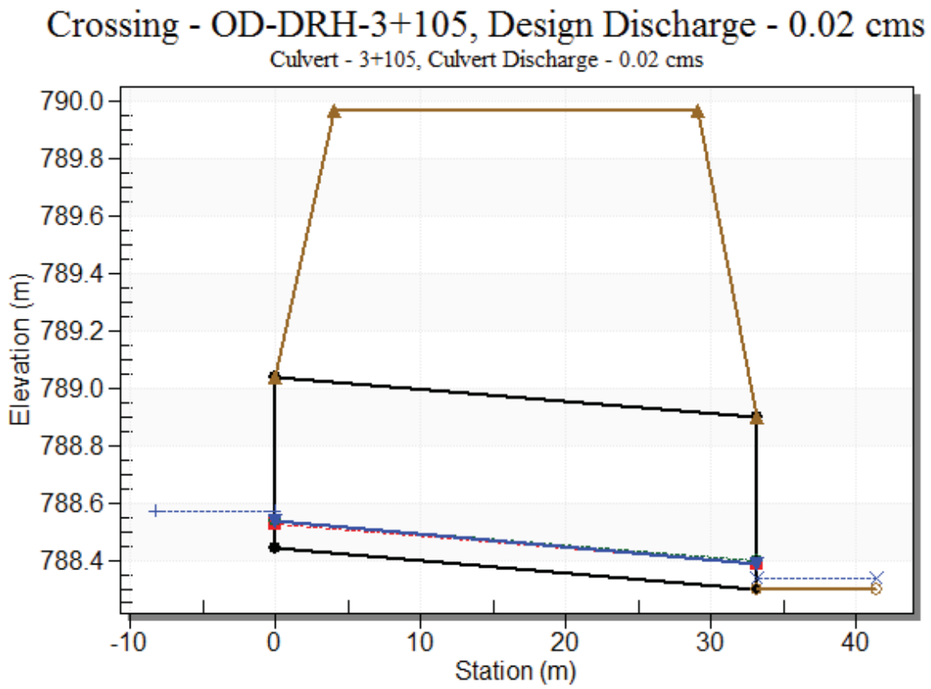
Straight Culvert

Inlet Elevation (invert): 788.44 m, Outlet Elevation (invert): 788.30 m

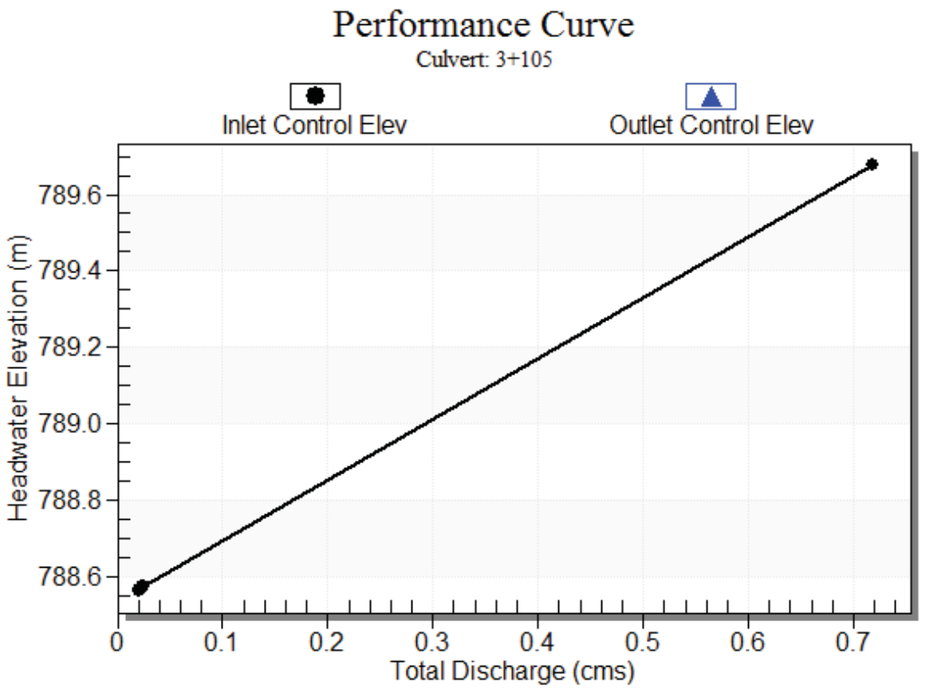
Culvert Length: 33.12 m, Culvert Slope: 0.0042

****

Water Surface Profile Plot for Culvert: 3+105



Culvert Performance Curve Plot: 3+105



HY-8 Culvert Analysis Report

Site Data - 1+480

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 787.42 m

Outlet Station: 28.64 m

Outlet Elevation: 787.27 m

Number of Barrels: 1

Culvert Data Summary - 1+480

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+480

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.15	0.15	787.73	0.312	0.0*	1-S2n	0.224	0.227	0.224	0.103	1.254	0.952
0.15	0.15	787.74	0.317	0.092	1-S2n	0.227	0.230	0.227	0.105	1.263	0.961
0.16	0.16	787.74	0.321	0.096	1-S2n	0.230	0.233	0.230	0.106	1.273	0.970
0.16	0.16	787.74	0.325	0.099	1-S2n	0.233	0.236	0.233	0.108	1.282	0.978
0.17	0.17	787.75	0.329	0.103	1-S2n	0.235	0.239	0.235	0.109	1.292	0.987
0.17	0.17	787.75	0.333	0.106	1-S2n	0.238	0.242	0.238	0.111	1.300	0.995
0.17	0.17	787.76	0.337	0.110	1-S2n	0.241	0.244	0.241	0.113	1.306	1.003
0.18	0.18	787.76	0.341	0.114	1-S2n	0.244	0.247	0.244	0.114	1.314	1.011
0.18	0.18	787.76	0.345	0.117	1-S2n	0.247	0.250	0.247	0.116	1.321	1.019
0.18	0.18	787.77	0.349	0.120	1-S2n	0.249	0.253	0.249	0.117	1.330	1.027
0.19	0.19	787.77	0.352	0.124	1-S2n	0.252	0.256	0.252	0.119	1.338	1.034

* Full Flow Headwater elevation is below inlet invert.

****

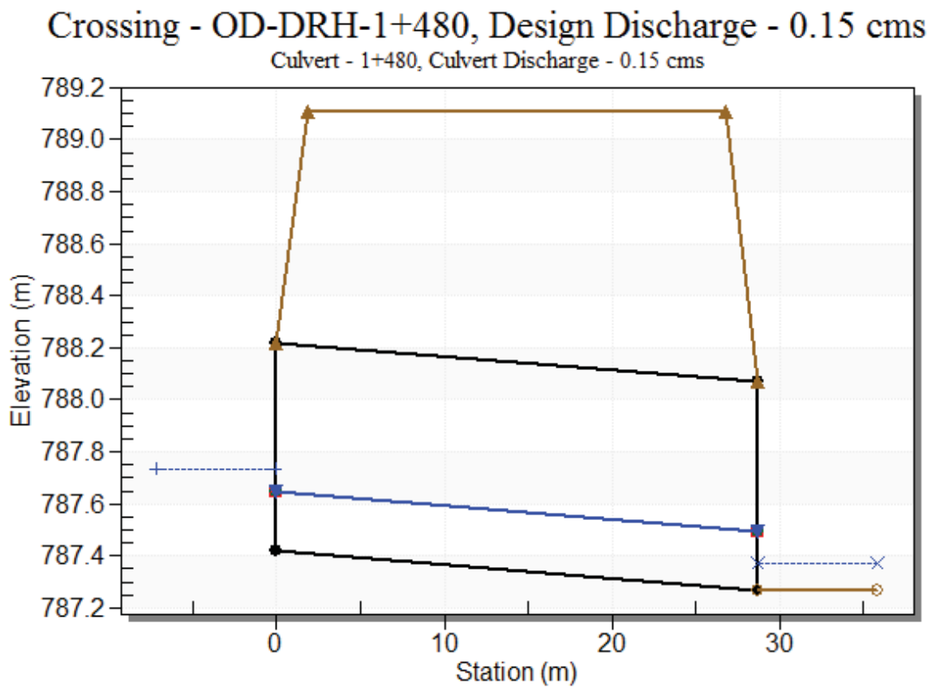
Straight Culvert

Inlet Elevation (invert): 787.42 m, Outlet Elevation (invert): 787.27 m

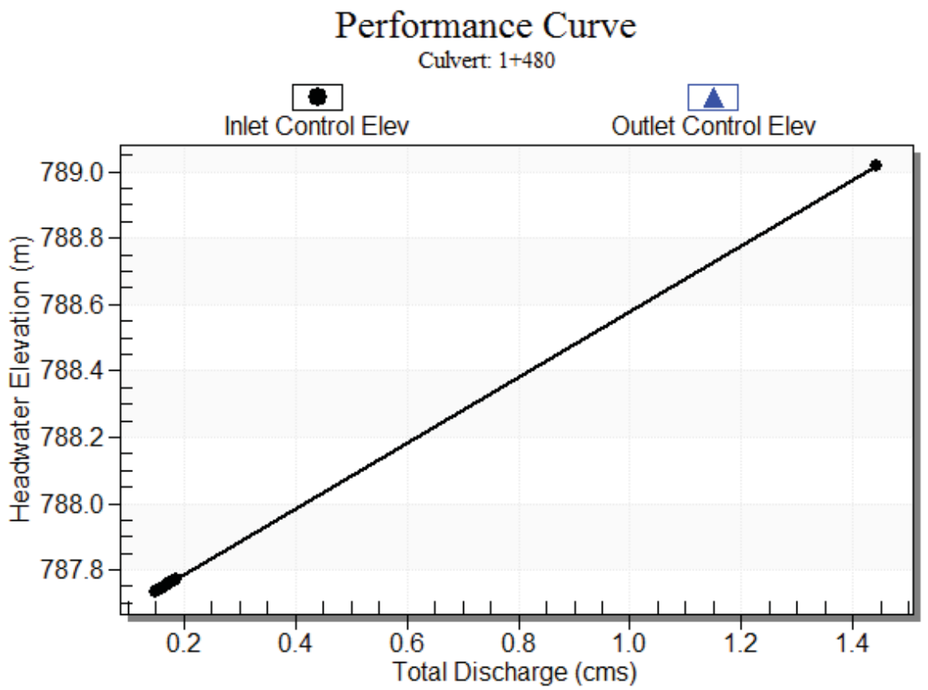
Culvert Length: 28.64 m, Culvert Slope: 0.0052

****

Water Surface Profile Plot for Culvert: 1+480



Culvert Performance Curve Plot: 1+480



HY-8 Culvert Analysis Report

Site Data - 1+600

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 787.57 m

Outlet Station: 29.40 m

Outlet Elevation: 787.43 m

Number of Barrels: 1

Culvert Data Summary - 1+600

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 1+600

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.04	0.04	787.74	0.158	0.173	2-M2c	0.119	0.115	0.115	0.046	0.896	0.582
0.04	0.04	787.75	0.160	0.176	2-M2c	0.120	0.117	0.117	0.047	0.901	0.588
0.04	0.04	787.75	0.161	0.178	2-M2c	0.122	0.118	0.118	0.047	0.907	0.594
0.04	0.04	787.75	0.163	0.180	2-M2c	0.123	0.120	0.120	0.048	0.912	0.599
0.04	0.04	787.75	0.165	0.182	2-M2c	0.125	0.121	0.121	0.049	0.917	0.604
0.04	0.04	787.75	0.167	0.184	2-M2c	0.126	0.123	0.123	0.050	0.923	0.609
0.05	0.05	787.76	0.169	0.187	2-M2c	0.127	0.124	0.124	0.050	0.928	0.614
0.05	0.05	787.76	0.171	0.189	2-M2c	0.128	0.125	0.125	0.051	0.933	0.620
0.05	0.05	787.76	0.173	0.193	2-M2c	0.130	0.127	0.127	0.052	0.938	0.625
0.05	0.05	787.76	0.175	0.195	2-M2c	0.131	0.128	0.128	0.052	0.943	0.629
0.05	0.05	787.77	0.177	0.197	2-M2c	0.132	0.129	0.129	0.053	0.947	0.635

****

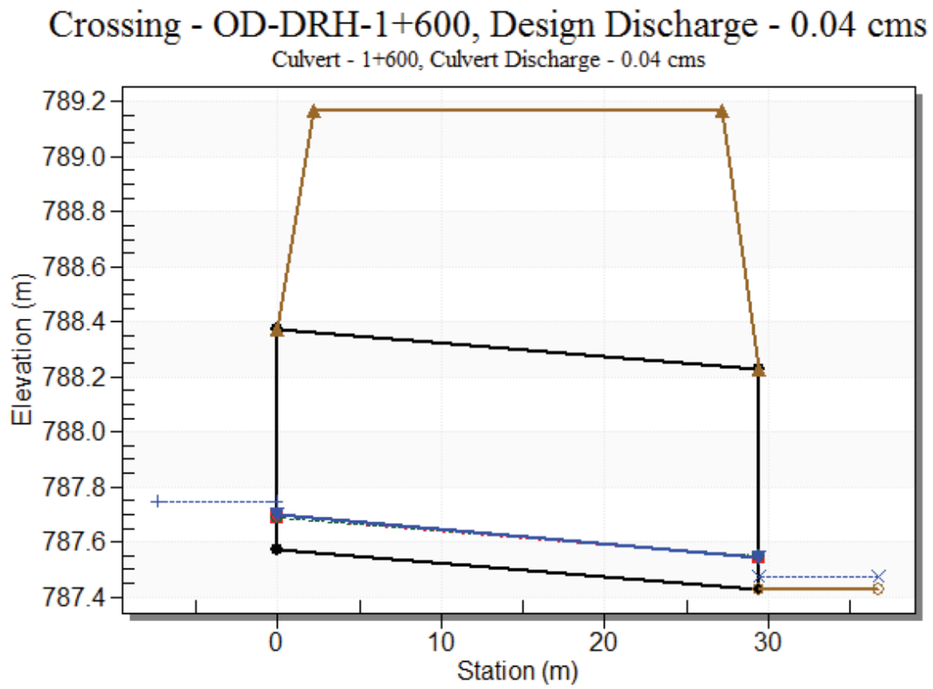
Straight Culvert

Inlet Elevation (invert): 787.57 m, Outlet Elevation (invert): 787.43 m

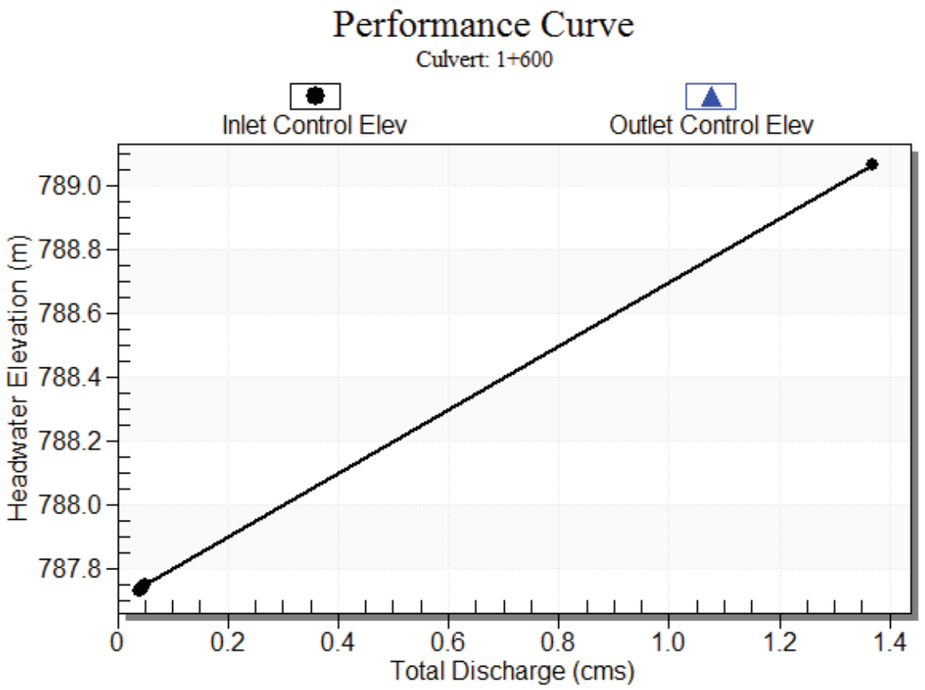
Culvert Length: 29.40 m, Culvert Slope: 0.0048

****

Water Surface Profile Plot for Culvert: 1+600



Culvert Performance Curve Plot: 1+600



HY-8 Culvert Analysis Report

Site Data - 0+832

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 787.02 m

Outlet Station: 29.72 m

Outlet Elevation: 786.87 m

Number of Barrels: 1

Culvert Data Summary - 0+832

Barrel Shape: Circular

Barrel Diameter: 1000.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+832

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.54	0.54	787.61	0.590	0.062	1-S2n	0.407	0.414	0.407	0.212	1.736	1.452
0.55	0.55	787.62	0.600	0.328	1-S2n	0.413	0.420	0.413	0.216	1.748	1.465
0.57	0.57	787.63	0.609	0.337	1-S2n	0.418	0.425	0.418	0.219	1.759	1.477
0.58	0.58	787.64	0.618	0.345	1-S2n	0.424	0.431	0.424	0.223	1.771	1.489
0.59	0.59	787.65	0.627	0.354	1-S2n	0.429	0.436	0.429	0.226	1.781	1.501
0.61	0.61	787.66	0.635	0.362	1-S2n	0.435	0.441	0.435	0.229	1.791	1.513
0.62	0.62	787.66	0.644	0.371	1-S2n	0.440	0.446	0.440	0.233	1.802	1.524
0.63	0.63	787.67	0.653	0.379	1-S2n	0.446	0.452	0.446	0.236	1.812	1.536
0.65	0.65	787.68	0.661	0.387	1-S2n	0.451	0.457	0.451	0.239	1.821	1.547
0.66	0.66	787.69	0.670	0.396	1-S2n	0.457	0.462	0.457	0.243	1.831	1.558
0.67	0.67	787.70	0.678	0.404	1-S2n	0.462	0.467	0.462	0.246	1.840	1.569

****

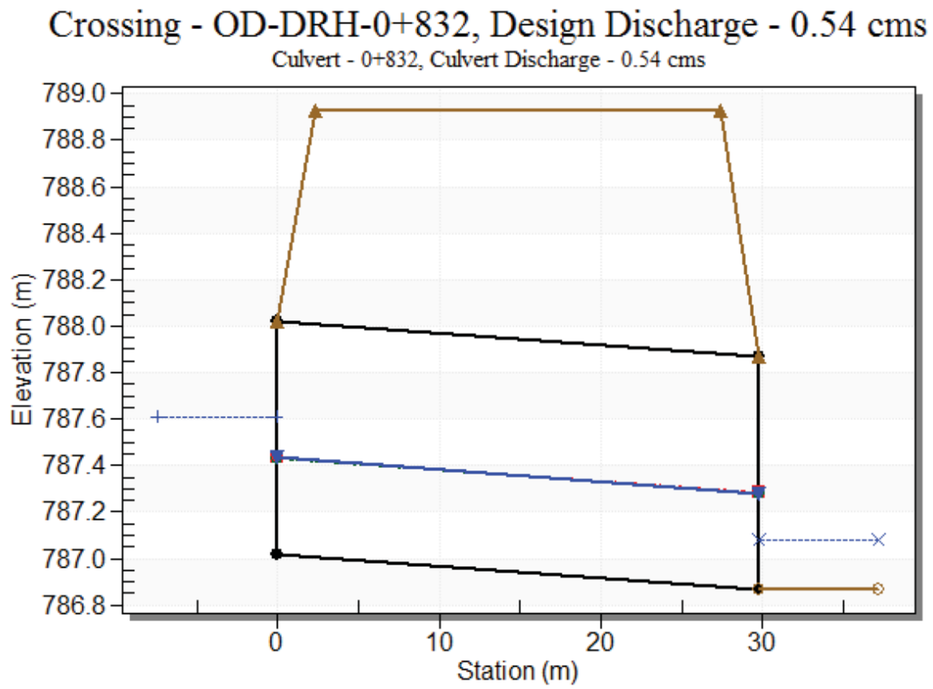
Straight Culvert

Inlet Elevation (invert): 787.02 m, Outlet Elevation (invert): 786.87 m

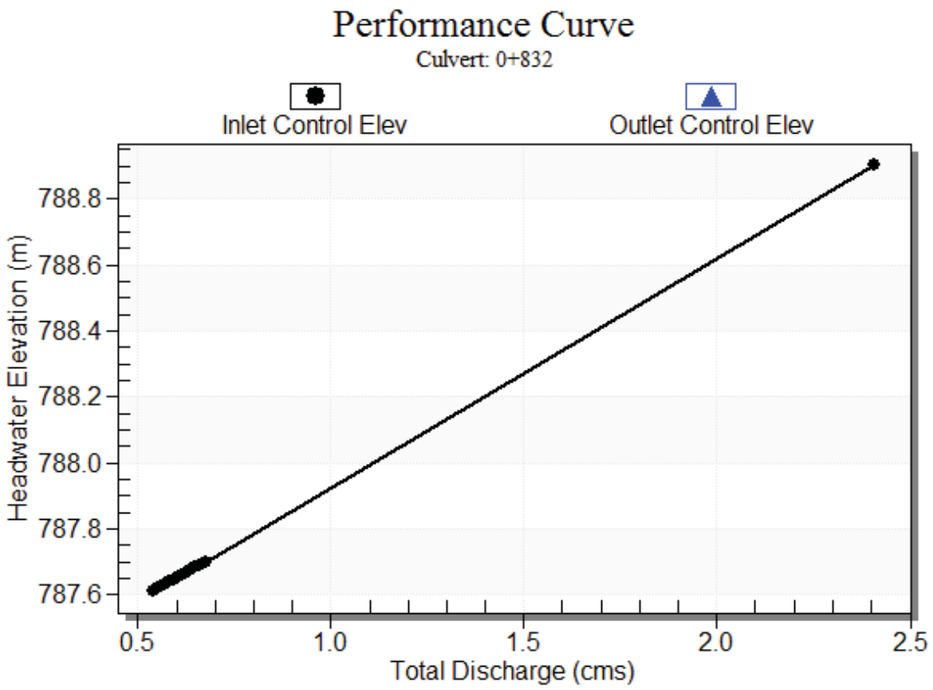
Culvert Length: 29.72 m, Culvert Slope: 0.0050

****

Water Surface Profile Plot for Culvert: 0+832



Culvert Performance Curve Plot: 0+832



HY-8 Culvert Analysis Report

Site Data - 2+777

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.43 m

Outlet Station: 70.80 m

Outlet Elevation: 789.27 m

Number of Barrels: 1

Culvert Data Summary - 2+777

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 2+777

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.02	0.02	789.56	0.121	0.135	2-M2c	0.111	0.087	0.087	0.033	0.796	0.467
0.02	0.02	789.57	0.122	0.136	2-M2c	0.112	0.088	0.088	0.033	0.800	0.471
0.02	0.02	789.57	0.124	0.138	2-M2c	0.114	0.089	0.089	0.034	0.805	0.475
0.02	0.02	789.57	0.125	0.140	2-M2c	0.115	0.090	0.090	0.034	0.809	0.480
0.02	0.02	789.57	0.127	0.141	2-M2c	0.116	0.091	0.091	0.035	0.813	0.484
0.02	0.02	789.57	0.127	0.143	2-M2c	0.117	0.092	0.092	0.035	0.817	0.488
0.02	0.02	789.57	0.129	0.144	2-M2c	0.119	0.093	0.093	0.036	0.821	0.492
0.02	0.02	789.58	0.130	0.146	2-M2c	0.120	0.094	0.094	0.036	0.825	0.497
0.02	0.02	789.58	0.132	0.148	2-M2c	0.121	0.095	0.095	0.037	0.829	0.501
0.02	0.02	789.58	0.133	0.149	2-M2c	0.123	0.096	0.096	0.037	0.833	0.505
0.03	0.03	789.58	0.135	0.151	2-M2c	0.124	0.097	0.097	0.037	0.837	0.509

****

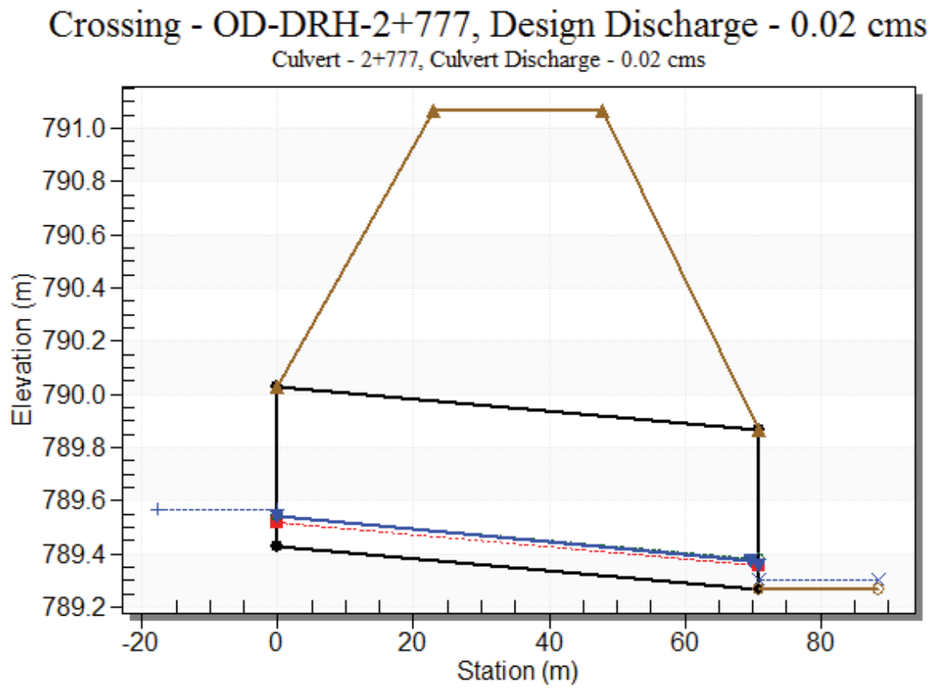
Straight Culvert

Inlet Elevation (invert): 789.43 m, Outlet Elevation (invert): 789.27 m

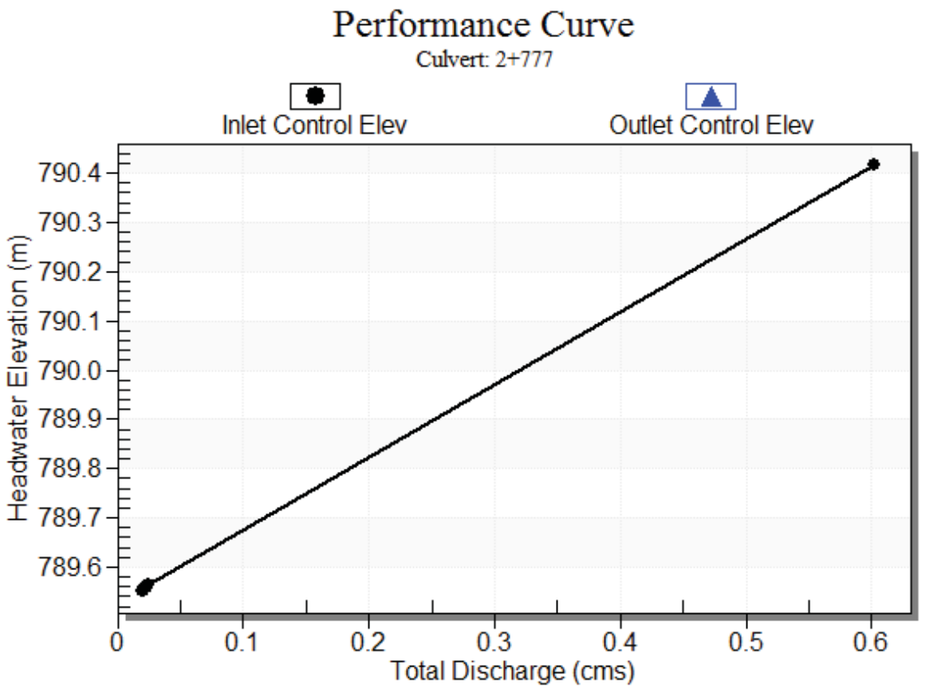
Culvert Length: 70.80 m, Culvert Slope: 0.0023

****

Water Surface Profile Plot for Culvert: 2+777



Culvert Performance Curve Plot: 2+777



HY-8 Culvert Analysis Report

Site Data - 2+908

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.67 m

Outlet Station: 29.28 m

Outlet Elevation: 788.53 m

Number of Barrels: 1

Culvert Data Summary - 2+908

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 2+908

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.03	0.03	788.82	0.136	0.151	2-M2c	0.103	0.099	0.099	0.039	0.835	0.521
0.03	0.03	788.82	0.137	0.153	2-M2c	0.105	0.101	0.101	0.039	0.840	0.526
0.03	0.03	788.82	0.139	0.155	2-M2c	0.106	0.102	0.102	0.040	0.845	0.530
0.03	0.03	788.83	0.141	0.156	2-M2c	0.107	0.103	0.103	0.040	0.849	0.535
0.03	0.03	788.83	0.142	0.158	2-M2c	0.108	0.104	0.104	0.041	0.853	0.539
0.03	0.03	788.83	0.144	0.160	2-M2c	0.109	0.105	0.105	0.041	0.858	0.544
0.03	0.03	788.83	0.145	0.162	2-M2c	0.110	0.106	0.106	0.042	0.862	0.548
0.03	0.03	788.83	0.147	0.163	2-M2c	0.111	0.107	0.107	0.042	0.866	0.552
0.04	0.04	788.83	0.149	0.163	2-M2c	0.112	0.109	0.109	0.043	0.871	0.557
0.04	0.04	788.83	0.150	0.165	2-M2c	0.113	0.110	0.110	0.043	0.875	0.561
0.04	0.04	788.84	0.152	0.167	2-M2c	0.114	0.111	0.111	0.044	0.879	0.565

****

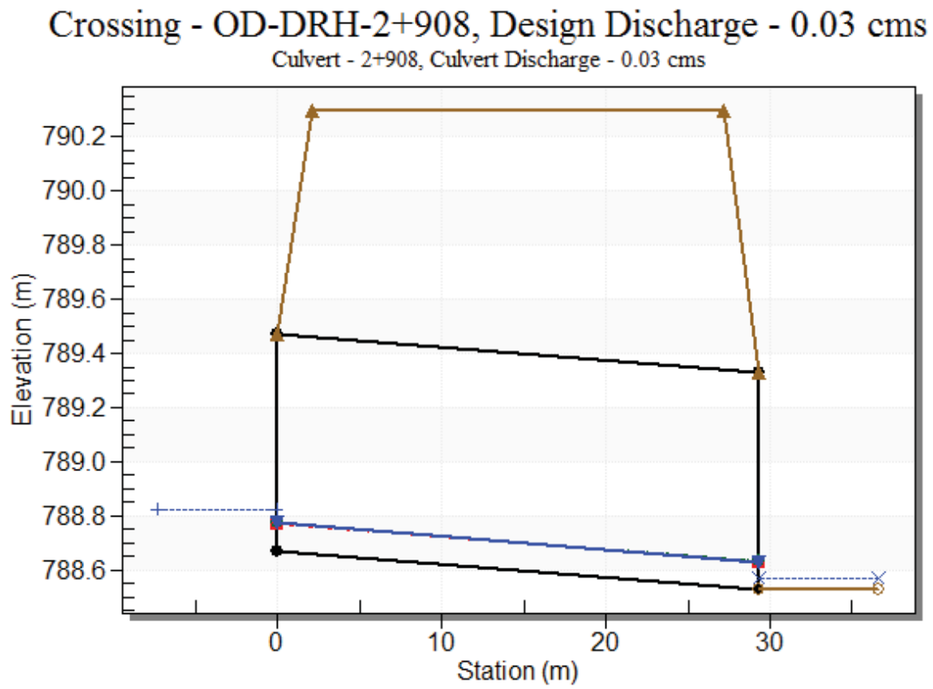
Straight Culvert

Inlet Elevation (invert): 788.67 m, Outlet Elevation (invert): 788.53 m

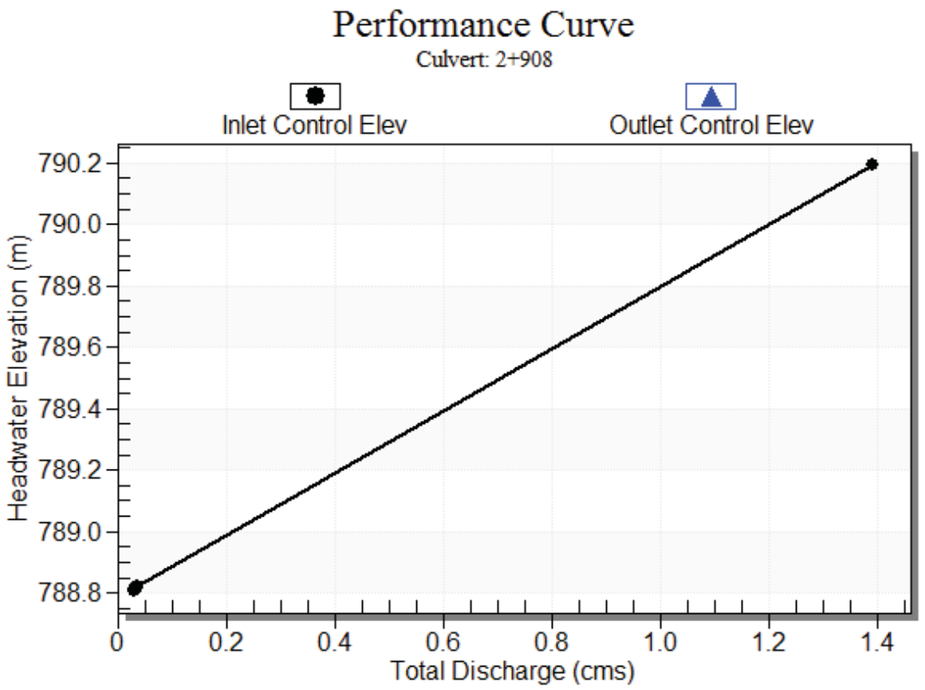
Culvert Length: 29.28 m, Culvert Slope: 0.0048

****

Water Surface Profile Plot for Culvert: 2+908



Culvert Performance Curve Plot: 2+908



HY-8 Culvert Analysis Report

Site Data - 2+540

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.94 m

Outlet Station: 29.14 m

Outlet Elevation: 788.88 m

Number of Barrels: 1

Culvert Data Summary - 2+540

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 2+540

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.01	0.01	789.03	0.078	0.088	2-M2c	0.074	0.057	0.057	0.026	0.635	0.257
0.01	0.01	789.03	0.079	0.089	2-M2c	0.075	0.058	0.058	0.027	0.639	0.260
0.01	0.01	789.03	0.080	0.091	2-M2c	0.076	0.058	0.058	0.027	0.643	0.263
0.01	0.01	789.03	0.081	0.092	2-M2c	0.078	0.059	0.059	0.028	0.647	0.266
0.01	0.01	789.03	0.082	0.093	2-M2c	0.079	0.060	0.060	0.028	0.651	0.268
0.01	0.01	789.03	0.084	0.095	2-M2c	0.080	0.061	0.061	0.028	0.655	0.271
0.01	0.01	789.04	0.085	0.096	2-M2c	0.081	0.062	0.062	0.029	0.659	0.274
0.01	0.01	789.04	0.086	0.097	2-M2c	0.082	0.063	0.063	0.029	0.663	0.277
0.01	0.01	789.04	0.087	0.098	2-M2c	0.083	0.063	0.063	0.030	0.666	0.279
0.01	0.01	789.04	0.088	0.099	2-M2c	0.084	0.064	0.064	0.030	0.670	0.282
0.01	0.01	789.04	0.089	0.101	2-M2c	0.085	0.065	0.065	0.031	0.674	0.284

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Straight Culvert

Inlet Elevation (invert): 788.94 m, Outlet Elevation (invert): 788.88 m

Culvert Length: 29.14 m, Culvert Slope: 0.0021

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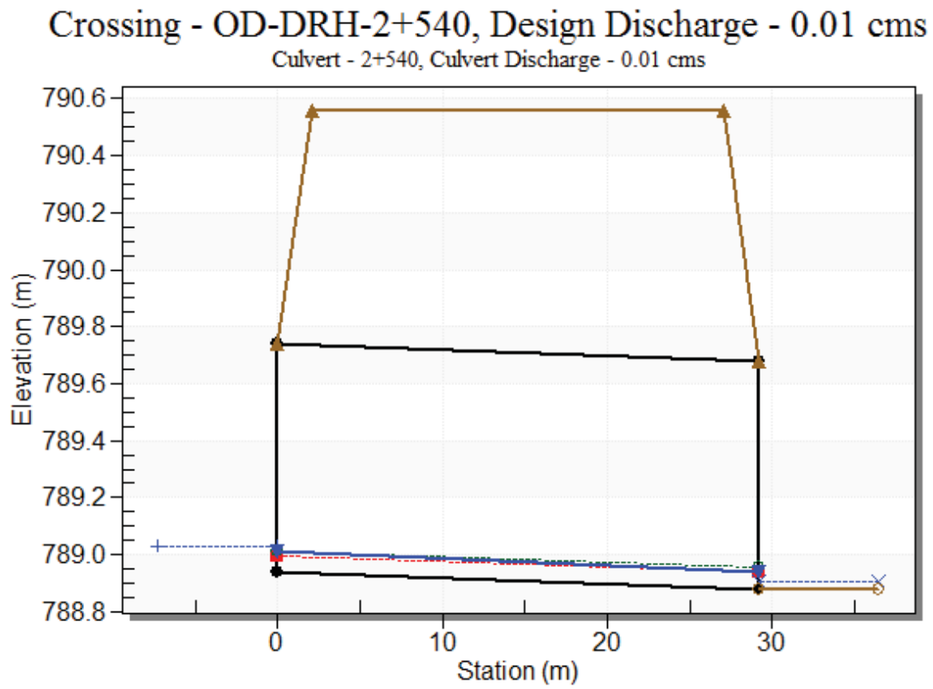
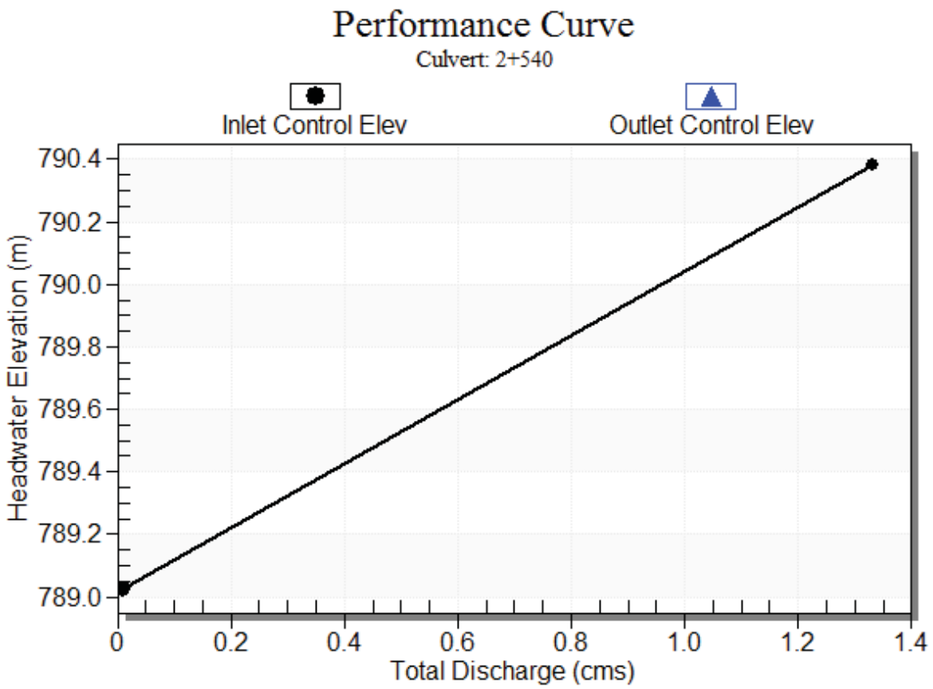
Water Surface Profile Plot for Culvert: 2+540



Culvert Performance Curve Plot: 2+540



HY-8 Culvert Analysis Report

Site Data - 2+270

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.12 m

Outlet Station: 28.70 m

Outlet Elevation: 787.97 m

Number of Barrels: 1

Culvert Data Summary - 2+270

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 2+270

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.14	0.14	788.42	0.302	0.0*	1-S2n	0.216	0.219	0.216	0.100	1.232	0.936
0.14	0.14	788.43	0.305	0.082	1-S2n	0.219	0.222	0.219	0.102	1.242	0.945
0.15	0.15	788.43	0.309	0.086	1-S2n	0.222	0.224	0.222	0.104	1.246	0.953
0.15	0.15	788.43	0.313	0.089	1-S2n	0.225	0.227	0.225	0.105	1.254	0.961
0.15	0.15	788.44	0.317	0.092	1-S2n	0.227	0.230	0.227	0.107	1.263	0.969
0.16	0.16	788.44	0.321	0.096	1-S2n	0.230	0.233	0.230	0.108	1.272	0.978
0.16	0.16	788.44	0.325	0.099	1-S2n	0.233	0.236	0.233	0.110	1.281	0.986
0.16	0.16	788.45	0.328	0.102	1-S2n	0.235	0.238	0.235	0.111	1.289	0.993
0.17	0.17	788.45	0.332	0.106	1-S2n	0.238	0.241	0.238	0.113	1.297	1.001
0.17	0.17	788.46	0.335	0.109	1-S2n	0.240	0.244	0.240	0.114	1.305	1.009
0.18	0.18	788.46	0.339	0.112	1-S2n	0.243	0.246	0.243	0.116	1.309	1.016

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 788.12 m, Outlet Elevation (invert): 787.97 m

Culvert Length: 28.70 m, Culvert Slope: 0.0052

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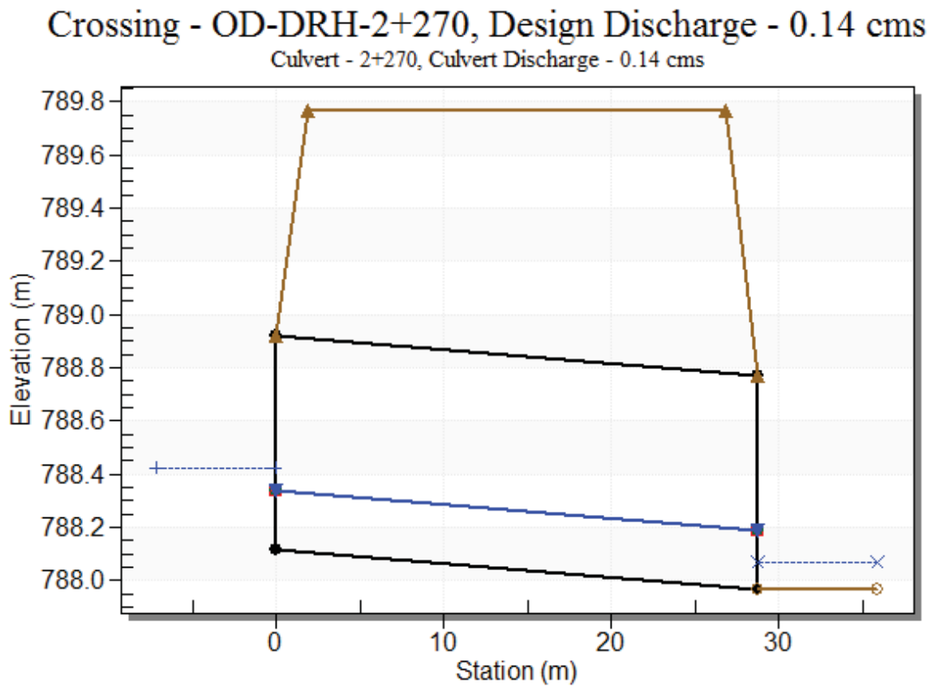
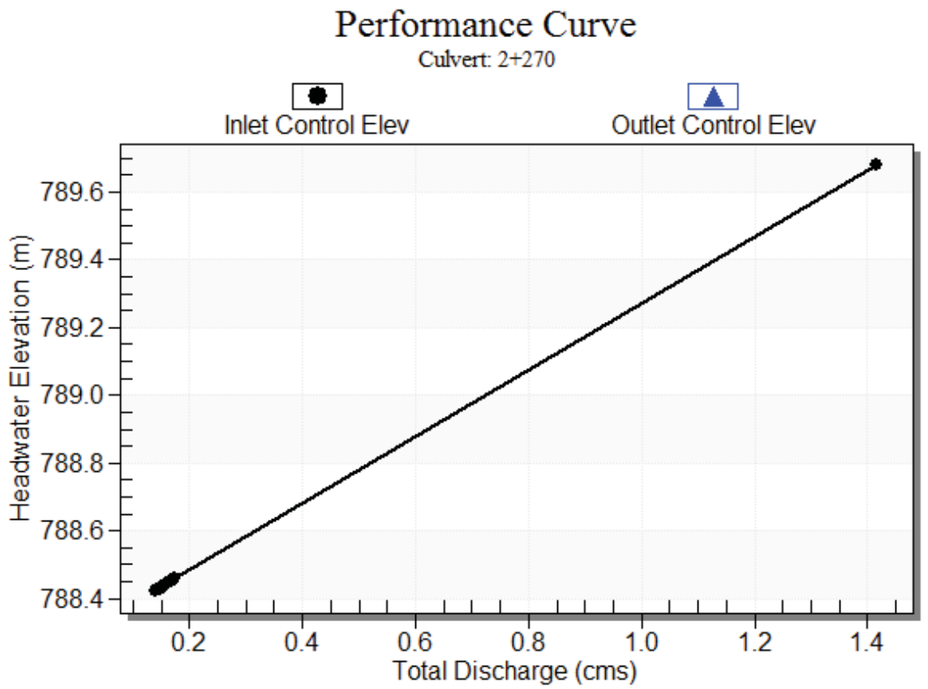
Water Surface Profile Plot for Culvert: 2+270



Culvert Performance Curve Plot: 2+270



HY-8 Culvert Analysis Report

Site Data - 0+565

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 790.28 m

Outlet Station: 20.34 m

Outlet Elevation: 790.17 m

Number of Barrels: 1

Culvert Data Summary - 0+565

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+565

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.02	0.02	790.41	0.114	0.126	2-M2c	0.085	0.083	0.083	0.031	0.761	0.448
0.02	0.02	790.41	0.115	0.128	2-M2c	0.086	0.084	0.084	0.031	0.765	0.452
0.02	0.02	790.41	0.116	0.129	2-M2c	0.087	0.085	0.085	0.032	0.769	0.455
0.02	0.02	790.41	0.118	0.131	2-M2c	0.088	0.086	0.086	0.032	0.773	0.460
0.02	0.02	790.41	0.119	0.132	2-M2c	0.089	0.086	0.086	0.032	0.792	0.463
0.02	0.02	790.41	0.120	0.133	2-M2c	0.090	0.087	0.087	0.033	0.796	0.467
0.02	0.02	790.41	0.122	0.135	2-M2c	0.090	0.087	0.087	0.033	0.799	0.470
0.02	0.02	790.42	0.123	0.136	2-M2c	0.091	0.088	0.088	0.034	0.803	0.474
0.02	0.02	790.42	0.124	0.137	2-M2c	0.092	0.089	0.089	0.034	0.806	0.478
0.02	0.02	790.42	0.125	0.139	2-M2c	0.093	0.090	0.090	0.034	0.810	0.481
0.02	0.02	790.42	0.127	0.140	2-M2c	0.094	0.091	0.091	0.035	0.813	0.484

****

Straight Culvert

Inlet Elevation (invert): 790.28 m, Outlet Elevation (invert): 790.17 m

Culvert Length: 20.34 m, Culvert Slope: 0.0054

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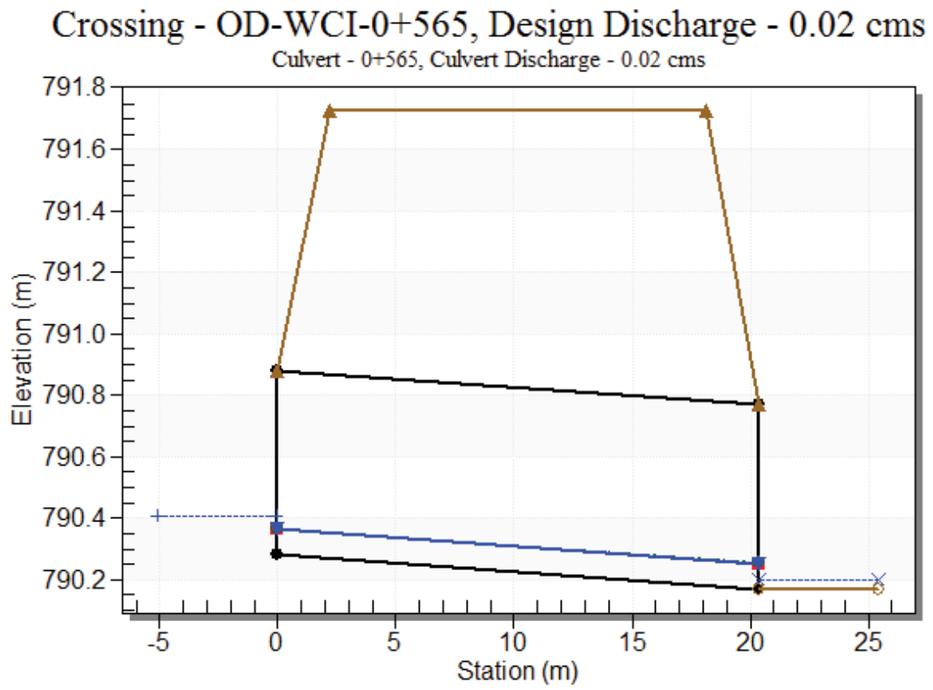
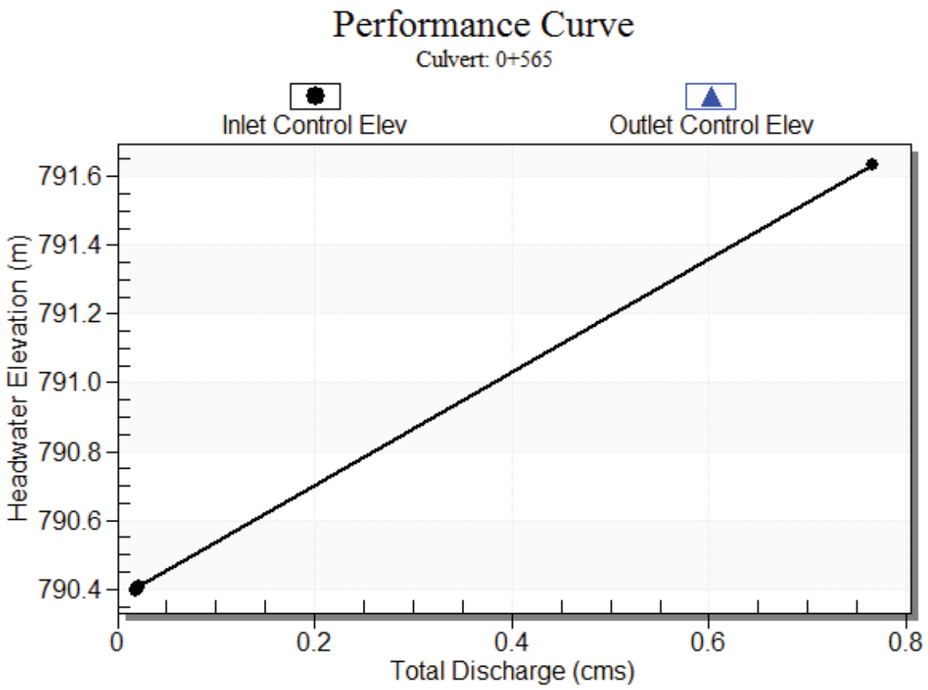
Water Surface Profile Plot for Culvert: 0+565



Culvert Performance Curve Plot: 0+565



HY-8 Culvert Analysis Report

Site Data - 0+265

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 790.03 m

Outlet Station: 39.54 m

Outlet Elevation: 789.71 m

Number of Barrels: 1

Culvert Data Summary - 0+265

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+265

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.03	0.03	790.18	0.147	0.0*	1-S2n	0.098	0.108	0.098	0.041	0.957	0.544
0.04	0.04	790.18	0.149	0.0*	1-S2n	0.099	0.109	0.099	0.042	0.963	0.549
0.04	0.04	790.18	0.150	0.0*	1-S2n	0.100	0.110	0.100	0.042	0.968	0.553
0.04	0.04	790.18	0.152	0.0*	1-S2n	0.101	0.111	0.101	0.043	0.974	0.558
0.04	0.04	790.18	0.154	0.0*	1-S2n	0.102	0.113	0.102	0.044	0.979	0.562
0.04	0.04	790.19	0.156	0.0*	1-S2n	0.103	0.114	0.103	0.044	0.987	0.567
0.04	0.04	790.19	0.157	0.0*	1-S2n	0.104	0.115	0.104	0.045	0.994	0.572
0.04	0.04	790.19	0.159	0.0*	1-S2n	0.105	0.116	0.105	0.045	1.002	0.576
0.04	0.04	790.19	0.161	0.0*	1-S2n	0.106	0.117	0.106	0.046	1.009	0.581
0.04	0.04	790.19	0.161	0.0*	1-S2n	0.107	0.119	0.107	0.046	1.017	0.585
0.04	0.04	790.19	0.163	0.0*	1-S2n	0.108	0.120	0.108	0.047	1.024	0.589

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 790.03 m, Outlet Elevation (invert): 789.71 m

Culvert Length: 39.54 m, Culvert Slope: 0.0081

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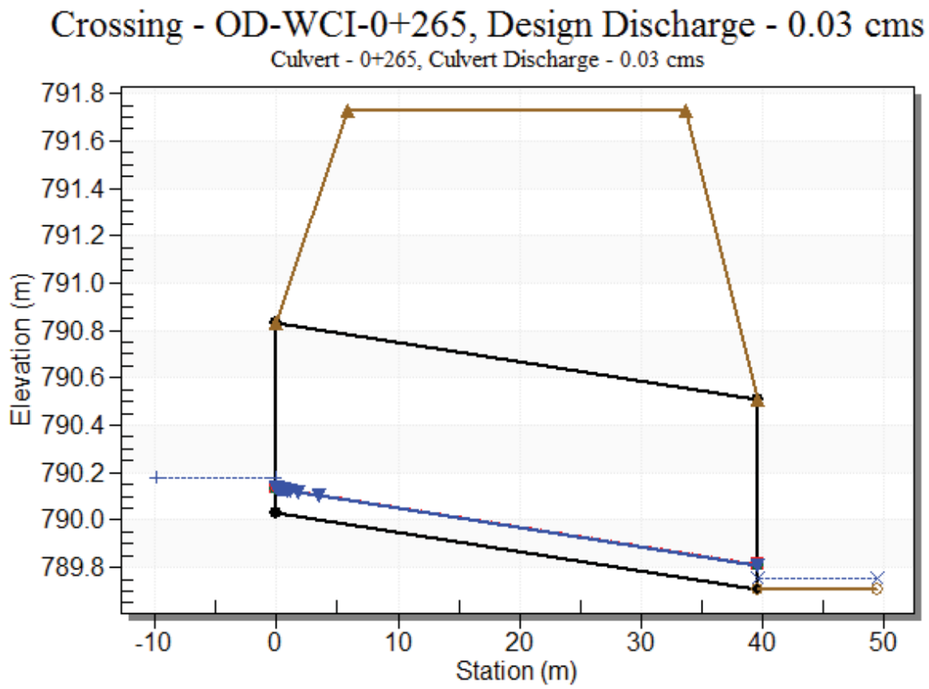
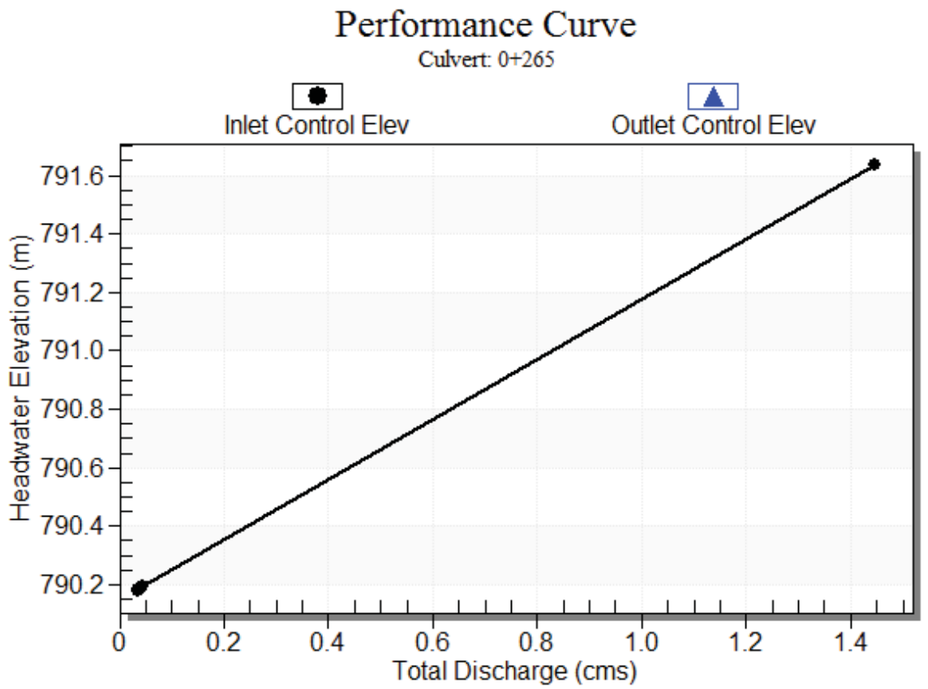
Water Surface Profile Plot for Culvert: 0+265



Culvert Performance Curve Plot: 0+265



HY-8 Culvert Analysis Report

Site Data - 0+110

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 790.45 m

Outlet Station: 19.50 m

Outlet Elevation: 790.38 m

Number of Barrels: 1

Culvert Data Summary - 0+110

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+110

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.01	0.01	790.53	0.071	0.077	2-M2c	0.060	0.050	0.050	0.017	0.615	0.309
0.01	0.01	790.53	0.072	0.078	2-M2c	0.060	0.051	0.051	0.018	0.618	0.313
0.01	0.01	790.53	0.073	0.079	2-M2c	0.061	0.052	0.052	0.018	0.622	0.316
0.01	0.01	790.53	0.074	0.081	2-M2c	0.062	0.053	0.053	0.018	0.625	0.320
0.01	0.01	790.53	0.075	0.082	2-M2c	0.063	0.053	0.053	0.018	0.628	0.323
0.01	0.01	790.53	0.076	0.083	2-M2c	0.064	0.054	0.054	0.019	0.632	0.326
0.01	0.01	790.53	0.077	0.084	2-M2c	0.064	0.055	0.055	0.019	0.635	0.329
0.01	0.01	790.53	0.078	0.085	2-M2c	0.065	0.056	0.056	0.019	0.638	0.333
0.01	0.01	790.54	0.079	0.086	2-M2c	0.066	0.056	0.056	0.020	0.641	0.336
0.01	0.01	790.54	0.080	0.087	2-M2c	0.066	0.057	0.057	0.020	0.645	0.339
0.01	0.01	790.54	0.081	0.088	2-M2c	0.067	0.058	0.058	0.020	0.648	0.342

****

Straight Culvert

Inlet Elevation (invert): 790.45 m, Outlet Elevation (invert): 790.38 m

Culvert Length: 19.50 m, Culvert Slope: 0.0036

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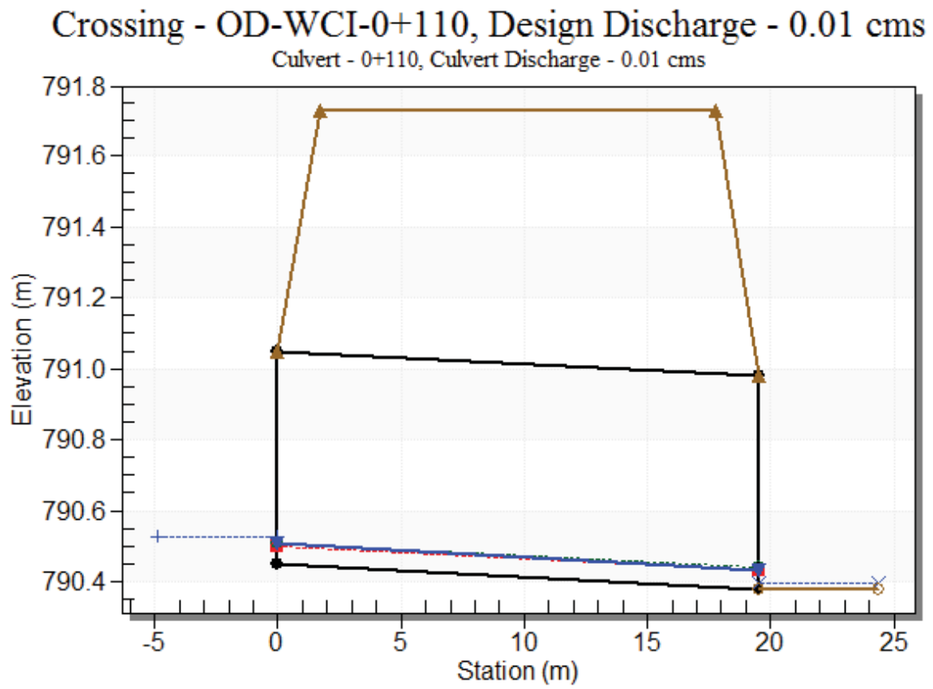
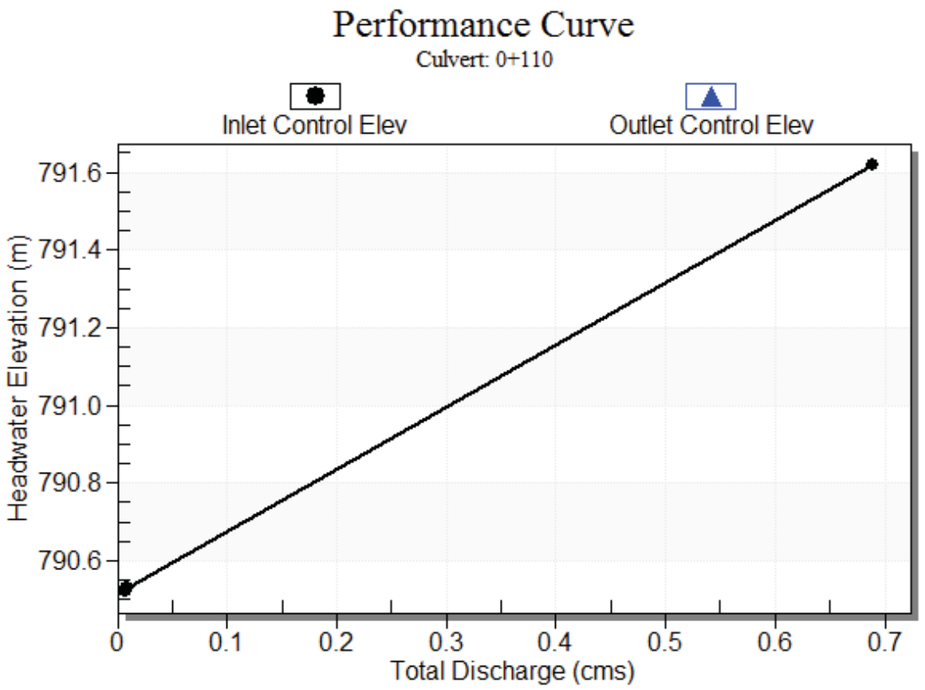
Water Surface Profile Plot for Culvert: 0+110



Culvert Performance Curve Plot: 0+110



HY-8 Culvert Analysis Report

Site Data - 0+140

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.78 m

Outlet Station: 12.43 m

Outlet Elevation: 789.72 m

Number of Barrels: 1

Culvert Data Summary - 0+140

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+140

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.06	0.06	790.02	0.212	0.235	2-M2c	0.159	0.153	0.153	0.074	1.053	0.645
0.06	0.06	790.02	0.214	0.239	2-M2c	0.161	0.155	0.155	0.075	1.060	0.651
0.06	0.06	790.02	0.217	0.242	2-M2c	0.163	0.157	0.157	0.076	1.066	0.657
0.06	0.06	790.02	0.220	0.245	2-M2c	0.165	0.159	0.159	0.077	1.073	0.662
0.07	0.07	790.03	0.222	0.248	2-M2c	0.167	0.161	0.161	0.078	1.079	0.668
0.07	0.07	790.03	0.225	0.251	2-M2c	0.169	0.163	0.163	0.080	1.085	0.674
0.07	0.07	790.03	0.228	0.254	2-M2c	0.171	0.165	0.165	0.081	1.091	0.679
0.07	0.07	790.04	0.230	0.256	2-M2c	0.173	0.167	0.167	0.082	1.097	0.685
0.07	0.07	790.04	0.233	0.259	2-M2c	0.175	0.169	0.169	0.083	1.103	0.690
0.07	0.07	790.04	0.235	0.262	2-M2c	0.176	0.171	0.171	0.084	1.109	0.695
0.07	0.07	790.05	0.238	0.265	2-M2c	0.178	0.173	0.173	0.085	1.115	0.700

****

Straight Culvert

Inlet Elevation (invert): 789.78 m, Outlet Elevation (invert): 789.72 m

Culvert Length: 12.43 m, Culvert Slope: 0.0048

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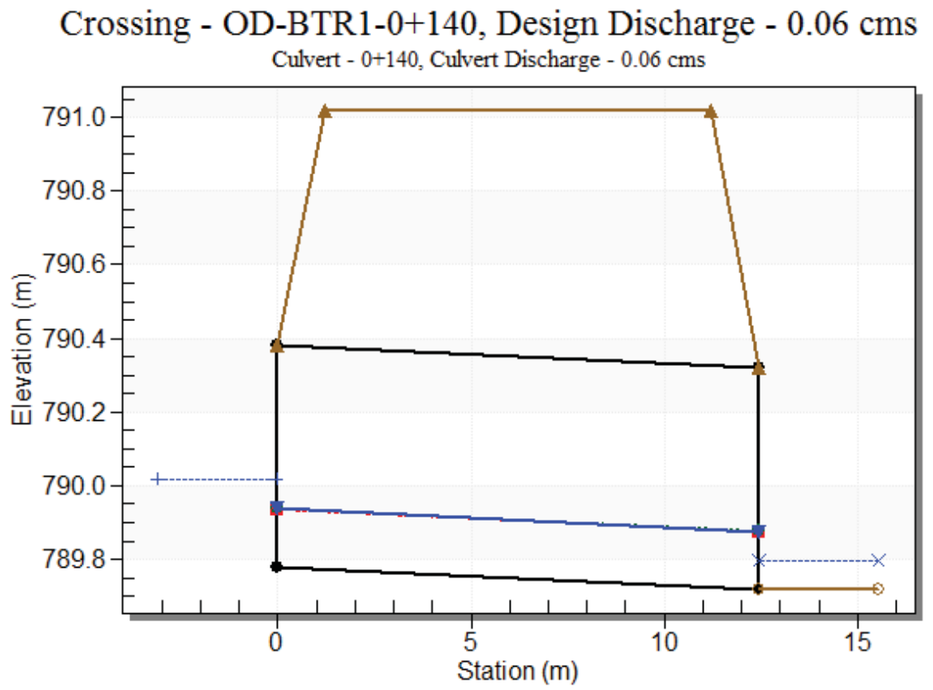
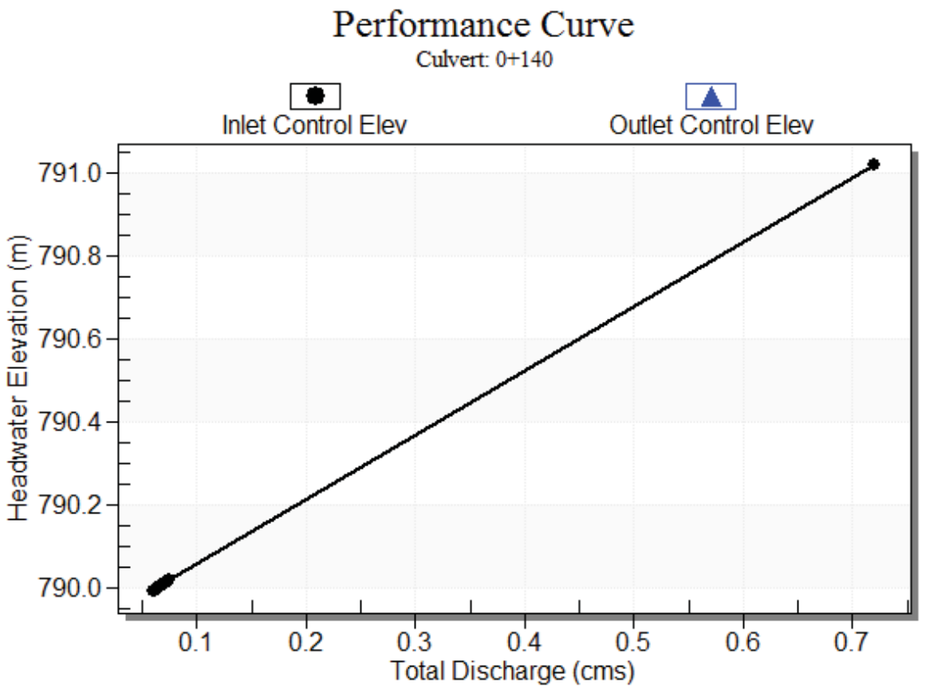
Water Surface Profile Plot for Culvert: 0+140



Culvert Performance Curve Plot: 0+140



HY-8 Culvert Analysis Report

Site Data - 0+240

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.88 m

Outlet Station: 8.61 m

Outlet Elevation: 789.85 m

Number of Barrels: 1

Culvert Data Summary - 0+240

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+240

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.02	0.02	790.01	0.120	0.132	2-M2c	0.100	0.087	0.087	0.038	0.796	0.426
0.02	0.02	790.01	0.122	0.134	2-M2c	0.101	0.088	0.088	0.038	0.800	0.429
0.02	0.02	790.02	0.124	0.135	2-M2c	0.102	0.089	0.089	0.039	0.805	0.434
0.02	0.02	790.02	0.125	0.137	2-M2c	0.103	0.090	0.090	0.039	0.809	0.437
0.02	0.02	790.02	0.127	0.138	2-M2c	0.104	0.091	0.091	0.040	0.813	0.442
0.02	0.02	790.02	0.127	0.140	2-M2c	0.106	0.092	0.092	0.040	0.817	0.446
0.02	0.02	790.02	0.129	0.142	2-M2c	0.107	0.093	0.093	0.041	0.821	0.449
0.02	0.02	790.02	0.130	0.143	2-M2c	0.108	0.094	0.094	0.042	0.825	0.453
0.02	0.02	790.02	0.132	0.145	2-M2c	0.109	0.095	0.095	0.042	0.829	0.457
0.02	0.02	790.03	0.133	0.146	2-M2c	0.110	0.096	0.096	0.043	0.833	0.460
0.03	0.03	790.03	0.135	0.148	2-M2c	0.111	0.097	0.097	0.043	0.837	0.464

****

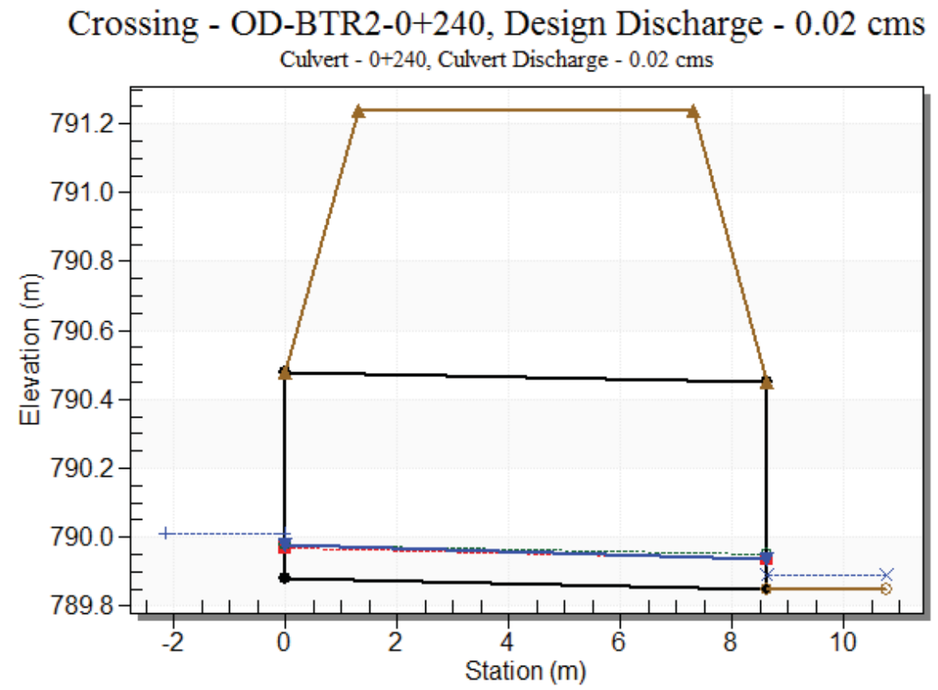
Straight Culvert

Inlet Elevation (invert): 789.88 m, Outlet Elevation (invert): 789.85 m

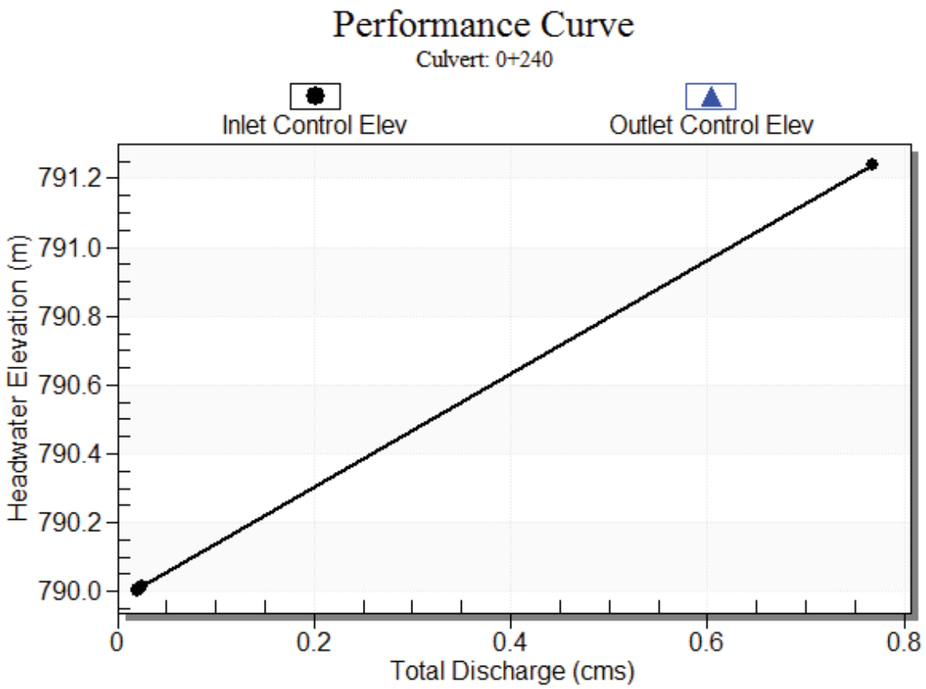
Culvert Length: 8.61 m, Culvert Slope: 0.0035

****

Water Surface Profile Plot for Culvert: 0+240



Culvert Performance Curve Plot: 0+240



HY-8 Culvert Analysis Report

Site Data - 0+245

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.32 m

Outlet Station: 44.76 m

Outlet Elevation: 789.16 m

Number of Barrels: 1

Culvert Data Summary - 0+245

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+245

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.02	0.02	789.45	0.120	0.132	2-M2c	0.099	0.087	0.087	0.038	0.796	0.426
0.02	0.02	789.45	0.122	0.134	2-M2c	0.100	0.088	0.088	0.038	0.800	0.429
0.02	0.02	789.46	0.124	0.135	2-M2c	0.101	0.089	0.089	0.039	0.805	0.434
0.02	0.02	789.46	0.125	0.137	2-M2c	0.103	0.090	0.090	0.039	0.809	0.437
0.02	0.02	789.46	0.127	0.138	2-M2c	0.104	0.091	0.091	0.040	0.813	0.442
0.02	0.02	789.46	0.127	0.140	2-M2c	0.105	0.092	0.092	0.040	0.817	0.446
0.02	0.02	789.46	0.129	0.142	2-M2c	0.106	0.093	0.093	0.041	0.821	0.449
0.02	0.02	789.46	0.130	0.143	2-M2c	0.107	0.094	0.094	0.042	0.825	0.453
0.02	0.02	789.46	0.132	0.145	2-M2c	0.108	0.095	0.095	0.042	0.829	0.457
0.02	0.02	789.47	0.133	0.146	2-M2c	0.110	0.096	0.096	0.043	0.833	0.460
0.03	0.03	789.47	0.134	0.148	2-M2c	0.111	0.097	0.097	0.043	0.837	0.464

****

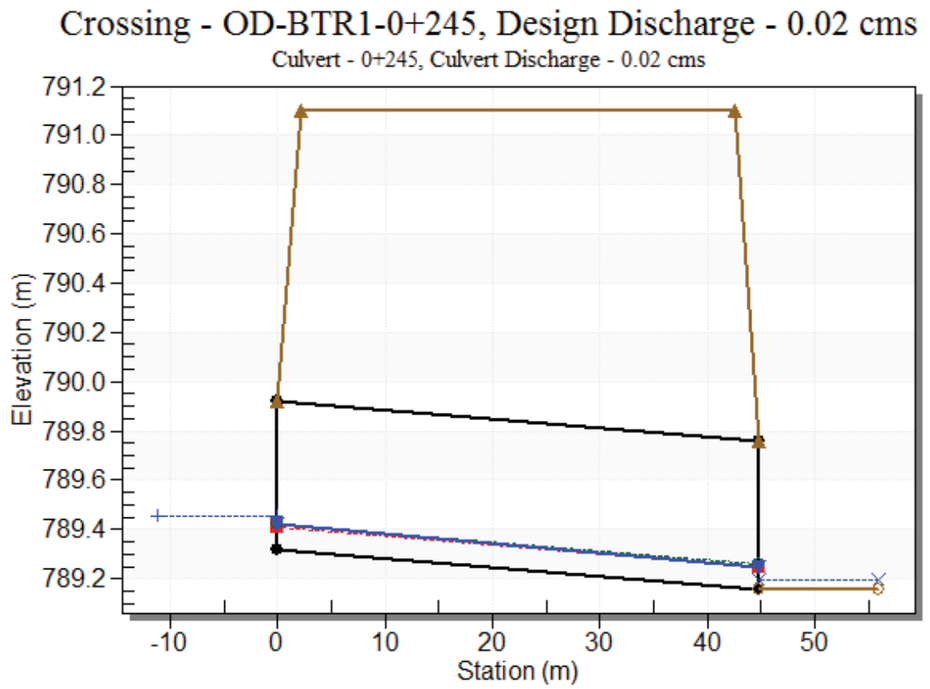
Straight Culvert

Inlet Elevation (invert): 789.32 m, Outlet Elevation (invert): 789.16 m

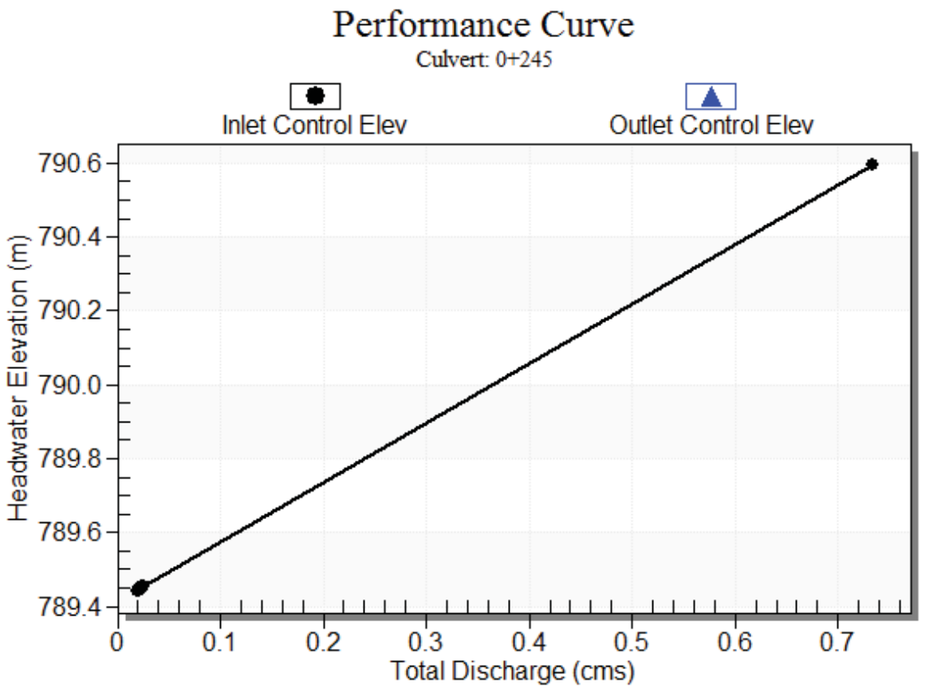
Culvert Length: 44.76 m, Culvert Slope: 0.0036

****

Water Surface Profile Plot for Culvert: 0+245



Culvert Performance Curve Plot: 0+245



HY-8 Culvert Analysis Report

Site Data - 0+360

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.87 m

Outlet Station: 7.96 m

Outlet Elevation: 789.85 m

Number of Barrels: 1

Culvert Data Summary - 0+360

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+360

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.01	0.01	789.96	0.086	0.094	2-M2c	0.077	0.061	0.061	0.025	0.663	0.325
0.01	0.01	789.97	0.085	0.095	2-M2c	0.078	0.062	0.062	0.025	0.667	0.329
0.01	0.01	789.97	0.087	0.097	2-M2c	0.079	0.063	0.063	0.025	0.672	0.333
0.01	0.01	789.97	0.088	0.098	2-M2c	0.080	0.064	0.064	0.026	0.676	0.336
0.01	0.01	789.97	0.089	0.100	2-M2c	0.081	0.065	0.065	0.026	0.680	0.340
0.01	0.01	789.97	0.091	0.101	2-M2c	0.082	0.066	0.066	0.027	0.684	0.344
0.01	0.01	789.97	0.092	0.102	2-M2c	0.083	0.067	0.067	0.027	0.688	0.347
0.01	0.01	789.97	0.093	0.103	2-M2c	0.084	0.067	0.067	0.028	0.692	0.350
0.01	0.01	789.97	0.094	0.105	2-M2c	0.085	0.068	0.068	0.028	0.696	0.354
0.01	0.01	789.98	0.096	0.106	2-M2c	0.086	0.069	0.069	0.028	0.700	0.357
0.01	0.01	789.98	0.097	0.107	2-M2c	0.087	0.070	0.070	0.029	0.704	0.360

****

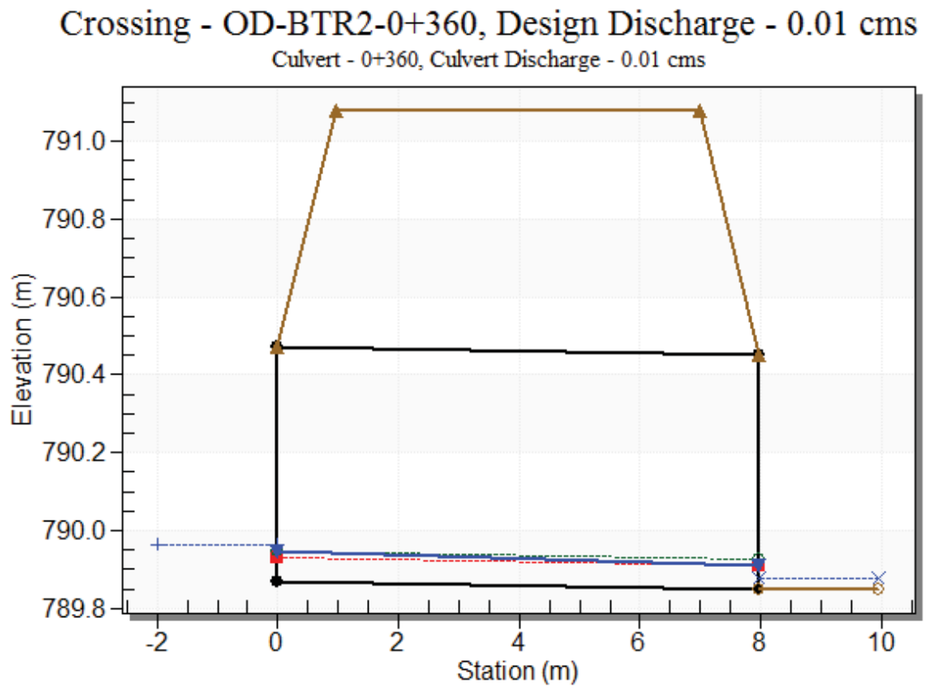
Straight Culvert

Inlet Elevation (invert): 789.87 m, Outlet Elevation (invert): 789.85 m

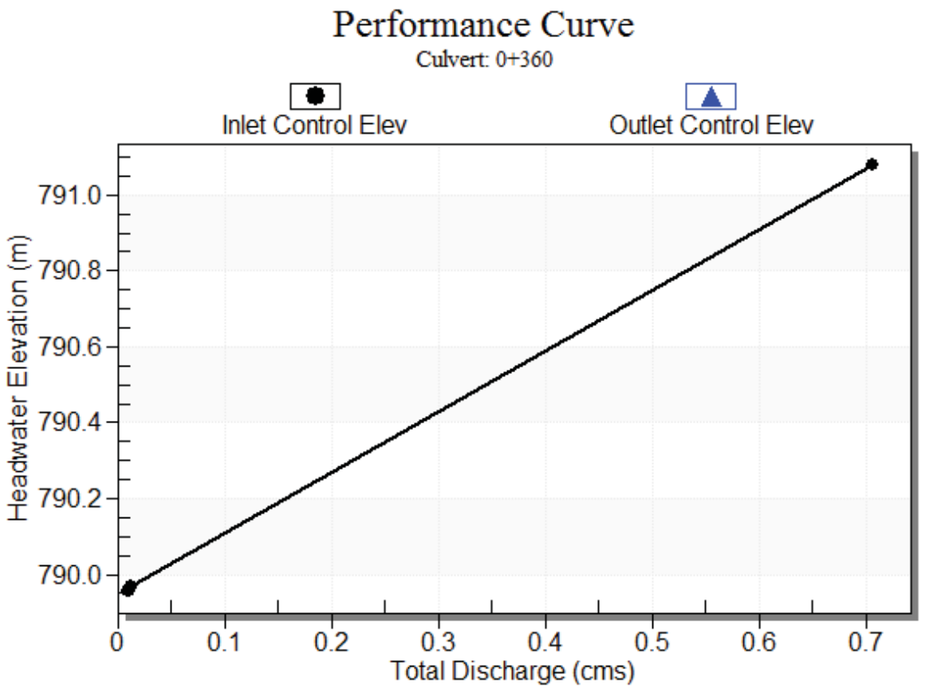
Culvert Length: 7.96 m, Culvert Slope: 0.0025

****

Water Surface Profile Plot for Culvert: 0+360



Culvert Performance Curve Plot: 0+360



HY-8 Culvert Analysis Report

Site Data - 0+227

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.75 m

Outlet Station: 10.79 m

Outlet Elevation: 789.33 m

Number of Barrels: 1

Culvert Data Summary - 0+227

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+227

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.23	0.23	790.20	0.455	0.0*	1-S2n	0.187	0.313	0.202	0.097	2.702	1.976
0.24	0.24	790.21	0.462	0.0*	1-S2n	0.190	0.317	0.205	0.099	2.718	1.994
0.25	0.25	790.22	0.469	0.0*	1-S2n	0.192	0.321	0.208	0.100	2.733	2.012
0.25	0.25	790.23	0.476	0.0*	1-S2n	0.194	0.325	0.210	0.102	2.747	2.029
0.26	0.26	790.23	0.483	0.0*	1-S2n	0.197	0.329	0.213	0.103	2.762	2.046
0.26	0.26	790.24	0.489	0.005	1-S2n	0.199	0.332	0.216	0.105	2.770	2.062
0.27	0.27	790.25	0.496	0.012	1-S2n	0.201	0.336	0.219	0.106	2.784	2.079
0.27	0.27	790.25	0.503	0.020	1-S2n	0.204	0.339	0.222	0.107	2.797	2.095
0.28	0.28	790.26	0.510	0.029	1-S2n	0.206	0.344	0.224	0.109	2.809	2.111
0.29	0.29	790.27	0.517	0.037	1-S2n	0.208	0.348	0.227	0.110	2.822	2.127
0.29	0.29	790.27	0.524	0.045	1-S2n	0.211	0.351	0.229	0.112	2.843	2.142

* Full Flow Headwater elevation is below inlet invert.

****

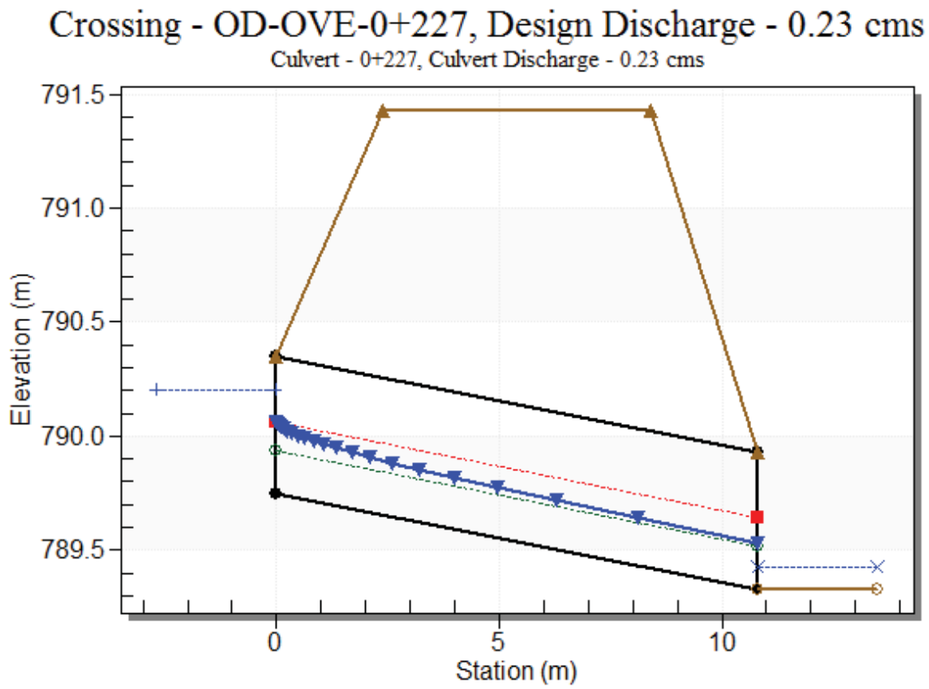
Straight Culvert

Inlet Elevation (invert): 789.75 m, Outlet Elevation (invert): 789.33 m

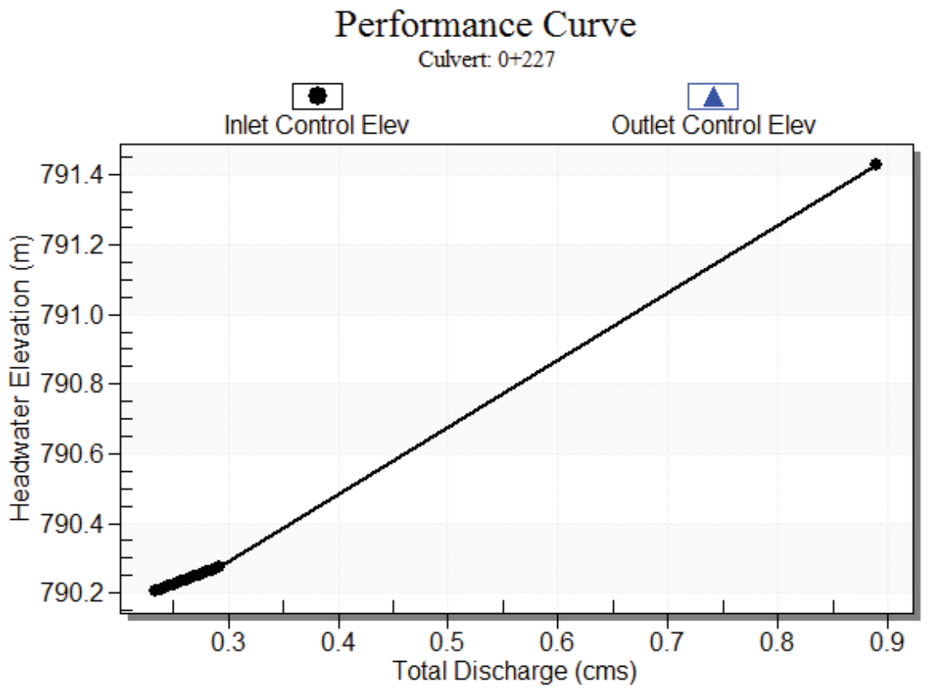
Culvert Length: 10.80 m, Culvert Slope: 0.0389

****

Water Surface Profile Plot for Culvert: 0+227



Culvert Performance Curve Plot: 0+227



HY-8 Culvert Analysis Report

Site Data - 0+100

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 788.86 m

Outlet Station: 12.53 m

Outlet Elevation: 788.80 m

Number of Barrels: 1

Culvert Data Summary - 0+100

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+100

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.06	0.06	789.09	0.210	0.233	2-M2c	0.158	0.152	0.152	0.064	1.049	0.707
0.06	0.06	789.10	0.212	0.236	2-M2c	0.160	0.154	0.154	0.065	1.055	0.713
0.06	0.06	789.10	0.215	0.239	2-M2c	0.162	0.156	0.156	0.066	1.061	0.719
0.06	0.06	789.10	0.217	0.242	2-M2c	0.164	0.158	0.158	0.067	1.067	0.725
0.06	0.06	789.10	0.220	0.245	2-M2c	0.165	0.159	0.159	0.067	1.073	0.731
0.07	0.07	789.11	0.222	0.248	2-M2c	0.167	0.161	0.161	0.068	1.079	0.738
0.07	0.07	789.11	0.225	0.250	2-M2c	0.169	0.163	0.163	0.069	1.085	0.743
0.07	0.07	789.11	0.227	0.253	2-M2c	0.171	0.165	0.165	0.070	1.090	0.749
0.07	0.07	789.12	0.230	0.256	2-M2c	0.173	0.167	0.167	0.071	1.096	0.755
0.07	0.07	789.12	0.232	0.258	2-M2c	0.174	0.168	0.168	0.072	1.102	0.761
0.07	0.07	789.12	0.234	0.261	2-M2c	0.176	0.170	0.170	0.073	1.107	0.766

****

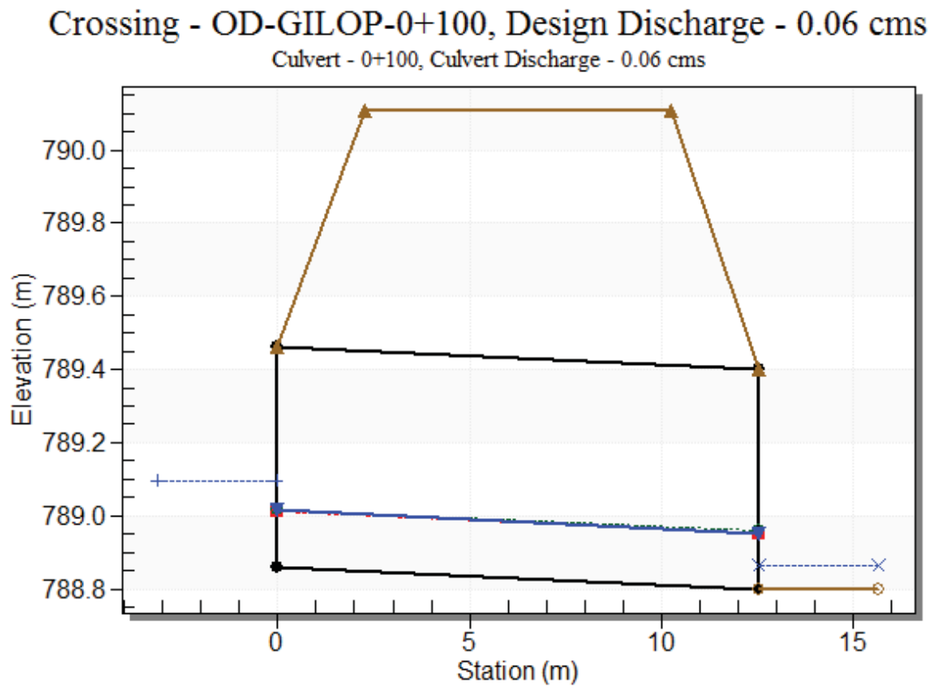
Straight Culvert

Inlet Elevation (invert): 788.86 m, Outlet Elevation (invert): 788.80 m

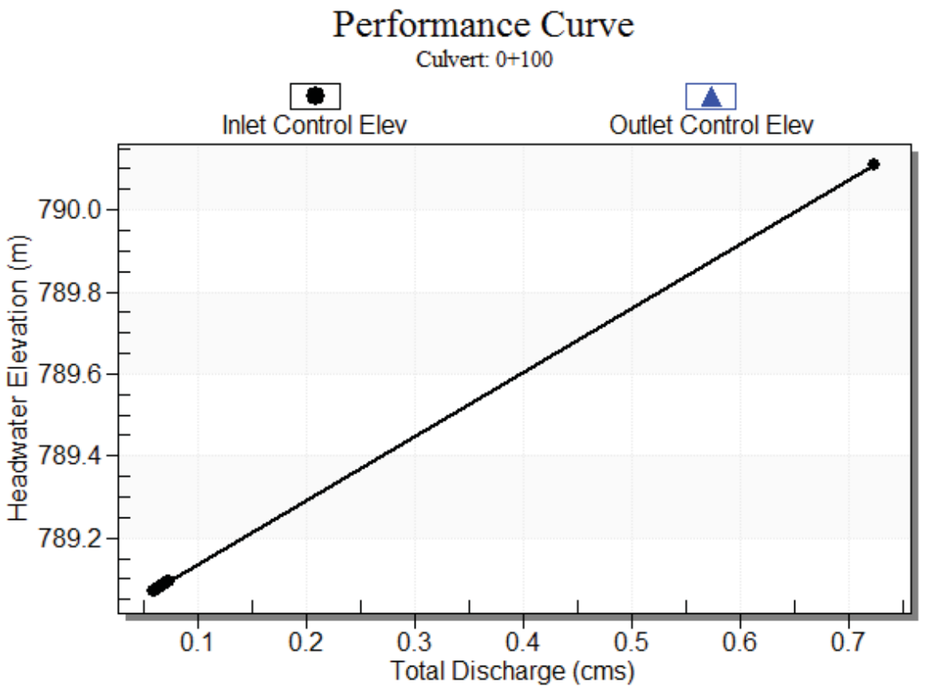
Culvert Length: 12.53 m, Culvert Slope: 0.0048

****

Water Surface Profile Plot for Culvert: 0+100



Culvert Performance Curve Plot: 0+100



HY-8 Culvert Analysis Report

Site Data - 0+065

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 787.97 m

Outlet Station: 10.91 m

Outlet Elevation: 787.92 m

Number of Barrels: 1

Culvert Data Summary - 0+065

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+065

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.11	0.11	788.29	0.290	0.323	2-M2c	0.220	0.209	0.209	0.097	1.241	0.902
0.11	0.11	788.30	0.294	0.327	2-M2c	0.223	0.212	0.212	0.098	1.249	0.910
0.11	0.11	788.30	0.298	0.331	2-M2c	0.226	0.215	0.215	0.100	1.257	0.918
0.12	0.12	788.31	0.302	0.336	2-M2c	0.229	0.218	0.218	0.101	1.265	0.926
0.12	0.12	788.31	0.306	0.340	2-M2c	0.232	0.220	0.220	0.103	1.273	0.934
0.12	0.12	788.31	0.311	0.344	2-M2c	0.235	0.223	0.223	0.104	1.281	0.942
0.13	0.13	788.32	0.315	0.348	2-M2c	0.237	0.226	0.226	0.106	1.289	0.949
0.13	0.13	788.32	0.320	0.352	2-M2c	0.240	0.228	0.228	0.107	1.296	0.956
0.13	0.13	788.33	0.324	0.356	2-M2c	0.243	0.230	0.230	0.108	1.312	0.963
0.13	0.13	788.33	0.328	0.360	2-M2c	0.246	0.232	0.232	0.110	1.319	0.971
0.14	0.14	788.33	0.332	0.364	2-M2c	0.249	0.235	0.235	0.111	1.326	0.978

****

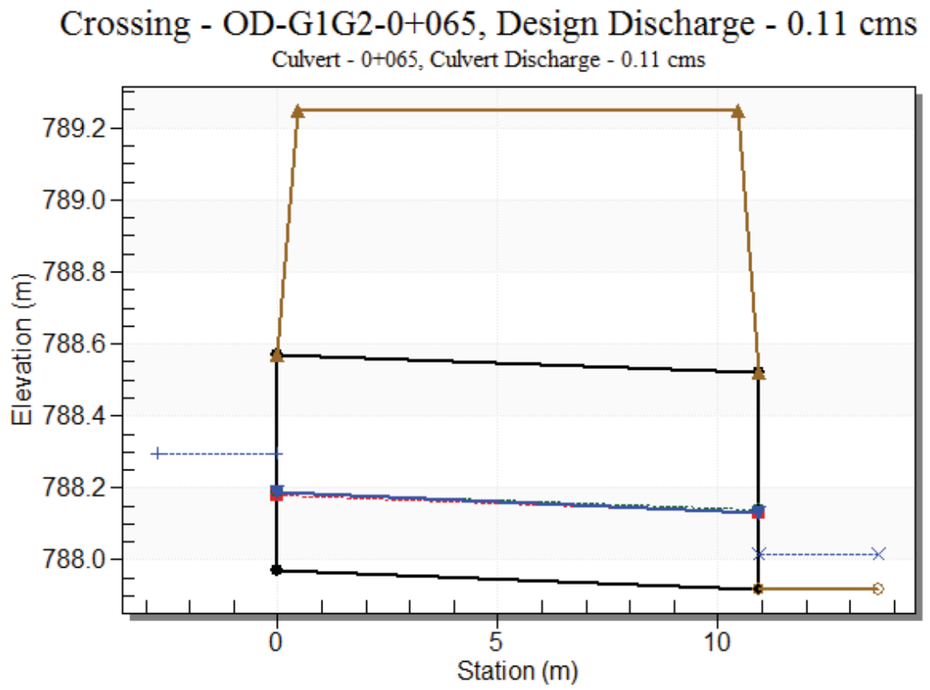
Straight Culvert

Inlet Elevation (invert): 787.97 m, Outlet Elevation (invert): 787.92 m

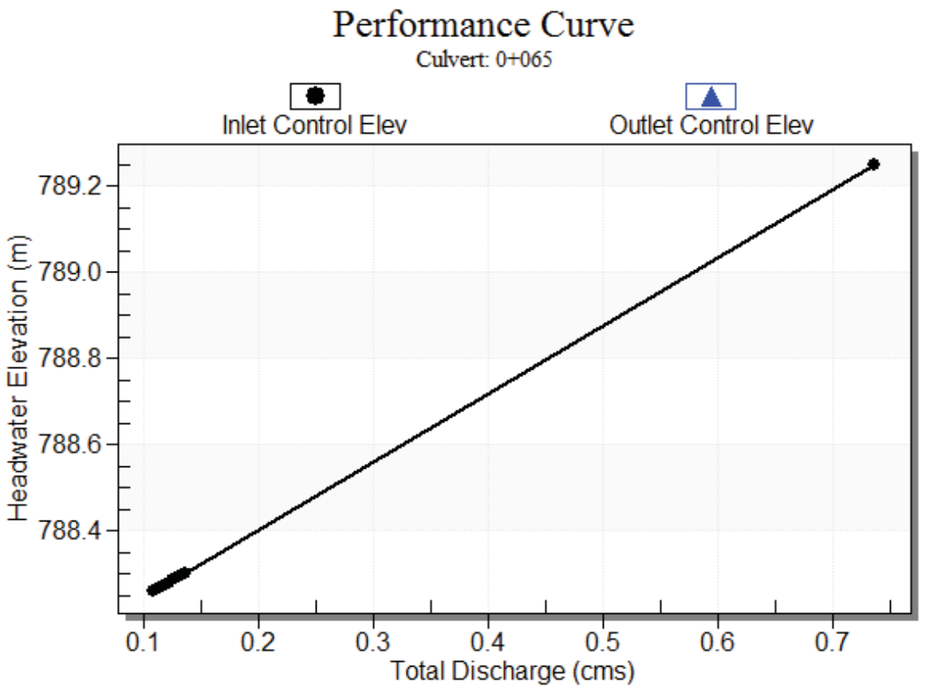
Culvert Length: 10.91 m, Culvert Slope: 0.0046

****

Water Surface Profile Plot for Culvert: 0+065



Culvert Performance Curve Plot: 0+065



HY-8 Culvert Analysis Report

Site Data - 0+020

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 791.69 m

Outlet Station: 18.82 m

Outlet Elevation: 791.65 m

Number of Barrels: 1

Culvert Data Summary - 0+020

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+020

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.04	0.04	791.88	0.165	0.186	2-M2c	0.153	0.120	0.120	0.049	0.921	0.598
0.04	0.04	791.88	0.167	0.188	2-M2c	0.155	0.121	0.121	0.049	0.927	0.604
0.04	0.04	791.88	0.169	0.190	2-M2c	0.157	0.123	0.123	0.050	0.932	0.609
0.04	0.04	791.88	0.171	0.192	2-M2c	0.159	0.124	0.124	0.051	0.937	0.615
0.04	0.04	791.88	0.173	0.195	2-M2c	0.161	0.126	0.126	0.052	0.943	0.620
0.04	0.04	791.89	0.175	0.197	2-M2c	0.162	0.127	0.127	0.052	0.948	0.625
0.04	0.04	791.89	0.177	0.199	2-M2c	0.164	0.129	0.129	0.053	0.953	0.630
0.04	0.04	791.89	0.179	0.201	2-M2c	0.166	0.130	0.130	0.054	0.958	0.635
0.04	0.04	791.89	0.181	0.203	2-M2c	0.168	0.132	0.132	0.054	0.964	0.640
0.05	0.05	791.90	0.183	0.206	2-M2c	0.170	0.133	0.133	0.055	0.969	0.645
0.05	0.05	791.90	0.185	0.208	2-M2c	0.171	0.134	0.134	0.056	0.973	0.650

****

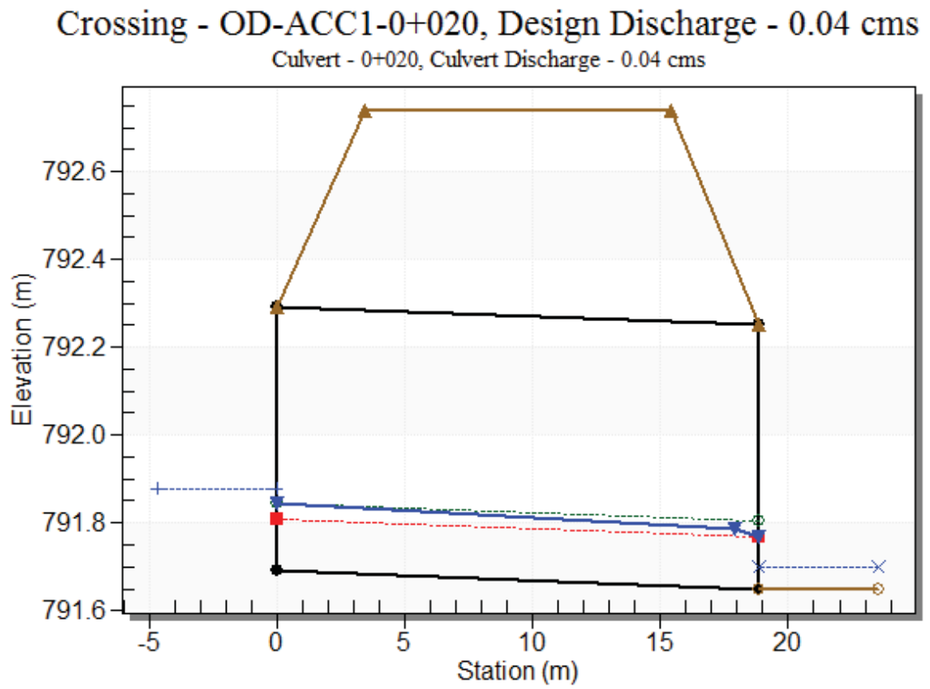
Straight Culvert

Inlet Elevation (invert): 791.69 m, Outlet Elevation (invert): 791.65 m

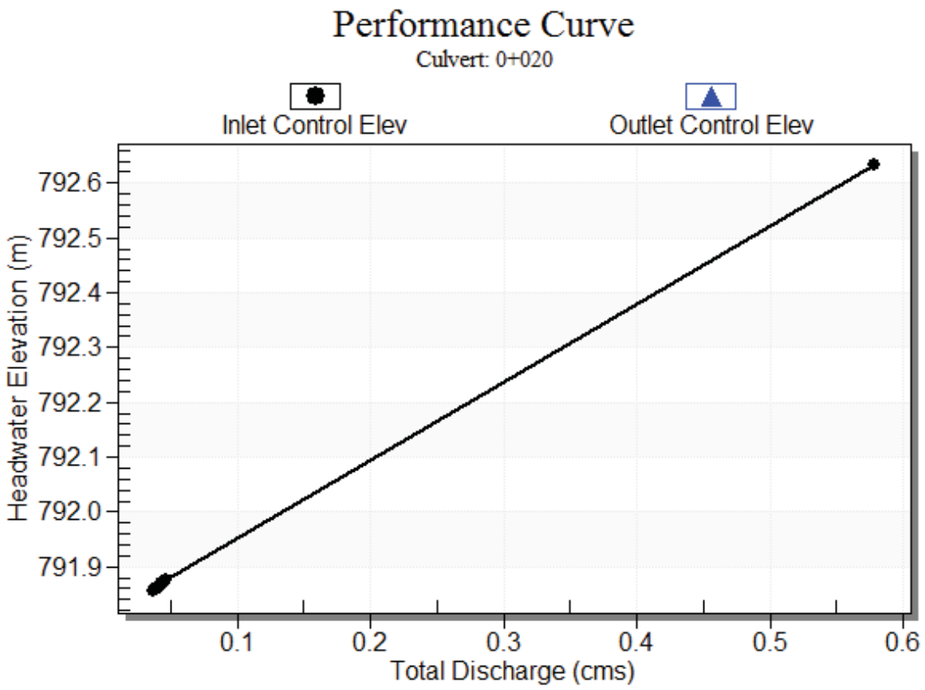
Culvert Length: 18.82 m, Culvert Slope: 0.0021

****

Water Surface Profile Plot for Culvert: 0+020



Culvert Performance Curve Plot: 0+020



HY-8 Culvert Analysis Report

Site Data - 0+340

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 791.47 m

Outlet Station: 10.13 m

Outlet Elevation: 791.41 m

Number of Barrels: 1

Culvert Data Summary - 0+340

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+340

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.01	0.01	791.54	0.065	0.072	2-M2c	0.049	0.046	0.046	0.016	0.597	0.297
0.01	0.01	791.54	0.065	0.073	2-M2c	0.049	0.047	0.047	0.016	0.598	0.298
0.01	0.01	791.54	0.066	0.073	2-M2c	0.050	0.047	0.047	0.016	0.600	0.301
0.01	0.01	791.54	0.067	0.074	2-M2c	0.050	0.048	0.048	0.017	0.602	0.303
0.01	0.01	791.54	0.067	0.075	2-M2c	0.050	0.048	0.048	0.017	0.604	0.304
0.01	0.01	791.55	0.068	0.075	2-M2c	0.051	0.048	0.048	0.017	0.606	0.306
0.01	0.01	791.55	0.068	0.076	2-M2c	0.051	0.049	0.049	0.017	0.608	0.308
0.01	0.01	791.55	0.069	0.076	2-M2c	0.051	0.049	0.049	0.017	0.609	0.309
0.01	0.01	791.55	0.069	0.077	2-M2c	0.052	0.050	0.050	0.017	0.611	0.311
0.01	0.01	791.55	0.070	0.078	2-M2c	0.052	0.050	0.050	0.018	0.613	0.313
0.01	0.01	791.55	0.071	0.078	2-M2c	0.053	0.050	0.050	0.018	0.615	0.315

****

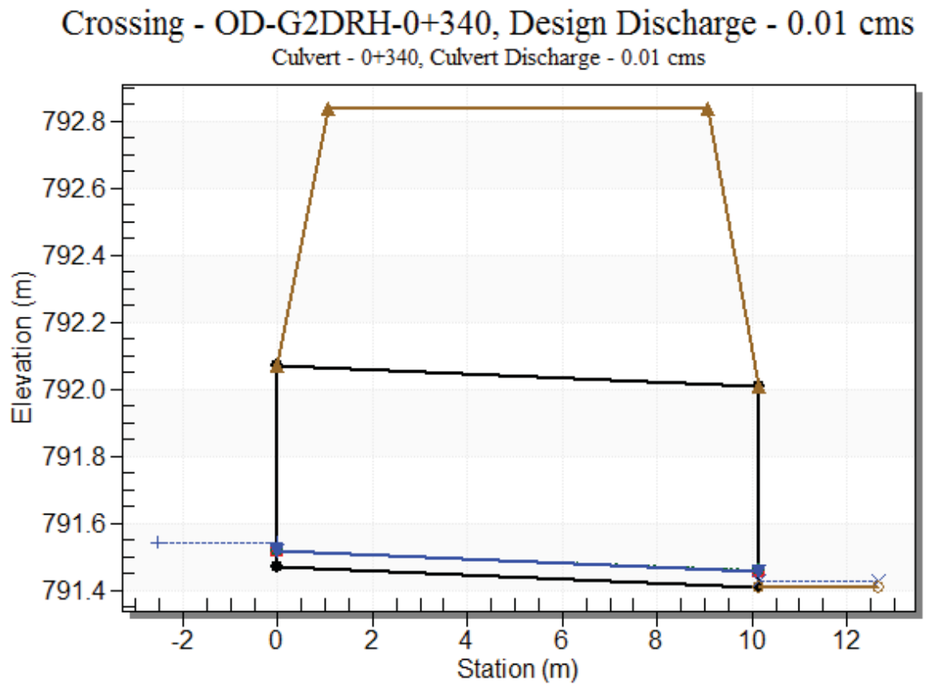
Straight Culvert

Inlet Elevation (invert): 791.47 m, Outlet Elevation (invert): 791.41 m

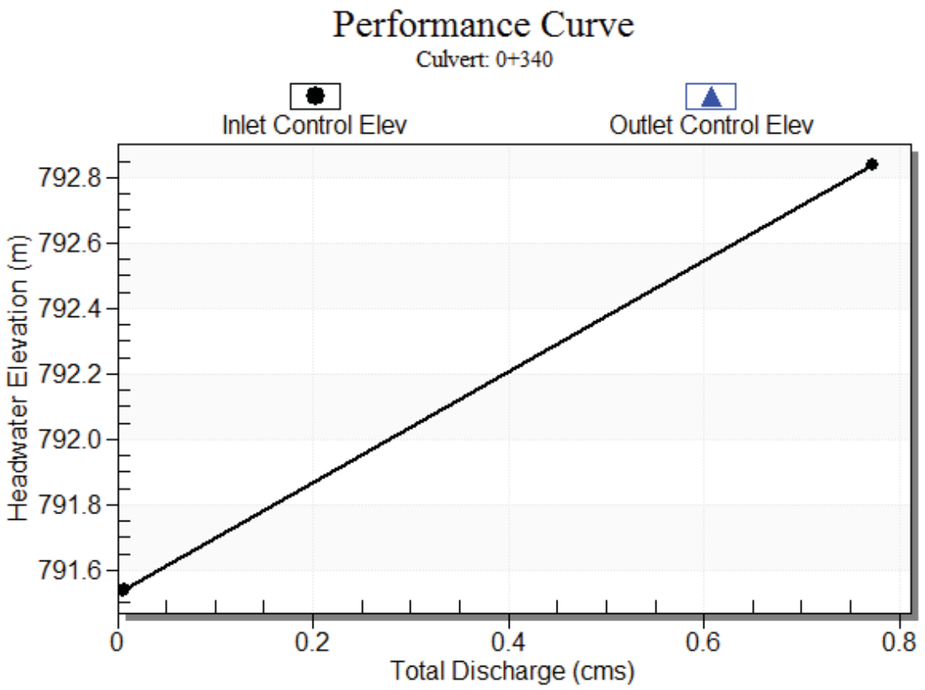
Culvert Length: 10.13 m, Culvert Slope: 0.0059

****

Water Surface Profile Plot for Culvert: 0+340



Culvert Performance Curve Plot: 0+340



HY-8 Culvert Analysis Report

Site Data - 0+710

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 789.97 m

Outlet Station: 10.92 m

Outlet Elevation: 789.95 m

Number of Barrels: 1

Culvert Data Summary - 0+710

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 1 - Culvert Summary Table: 0+710

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.05	0.05	790.18	0.187	0.210	2-M2c	0.180	0.136	0.136	0.057	0.979	0.659
0.05	0.05	790.18	0.189	0.212	2-M2c	0.182	0.137	0.137	0.058	0.985	0.665
0.05	0.05	790.18	0.191	0.215	2-M2c	0.184	0.139	0.139	0.059	0.991	0.671
0.05	0.05	790.19	0.193	0.217	2-M2c	0.186	0.141	0.141	0.060	0.996	0.676
0.05	0.05	790.19	0.195	0.220	2-M2c	0.189	0.142	0.142	0.060	1.002	0.682
0.05	0.05	790.19	0.198	0.222	2-M2c	0.191	0.144	0.144	0.061	1.008	0.687
0.05	0.05	790.19	0.200	0.224	2-M2c	0.193	0.144	0.144	0.062	1.024	0.693
0.05	0.05	790.20	0.202	0.227	2-M2c	0.195	0.146	0.146	0.063	1.029	0.698
0.06	0.06	790.20	0.204	0.229	2-M2c	0.197	0.147	0.147	0.063	1.034	0.703
0.06	0.06	790.20	0.206	0.232	2-M2c	0.199	0.149	0.149	0.064	1.039	0.708
0.06	0.06	790.20	0.209	0.234	2-M2c	0.201	0.151	0.151	0.065	1.044	0.713

****

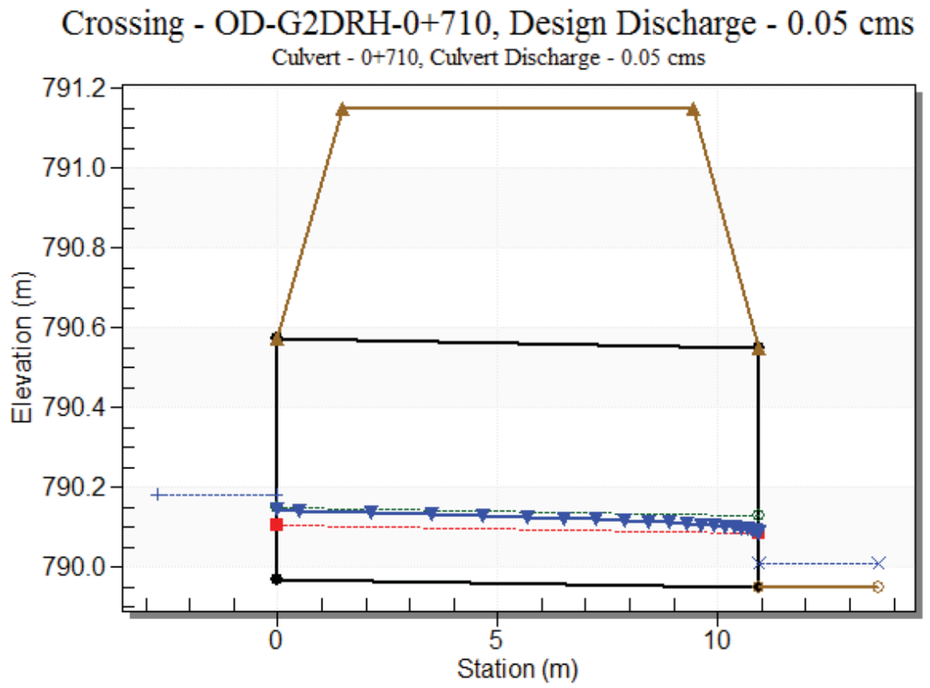
Straight Culvert

Inlet Elevation (invert): 789.97 m, Outlet Elevation (invert): 789.95 m

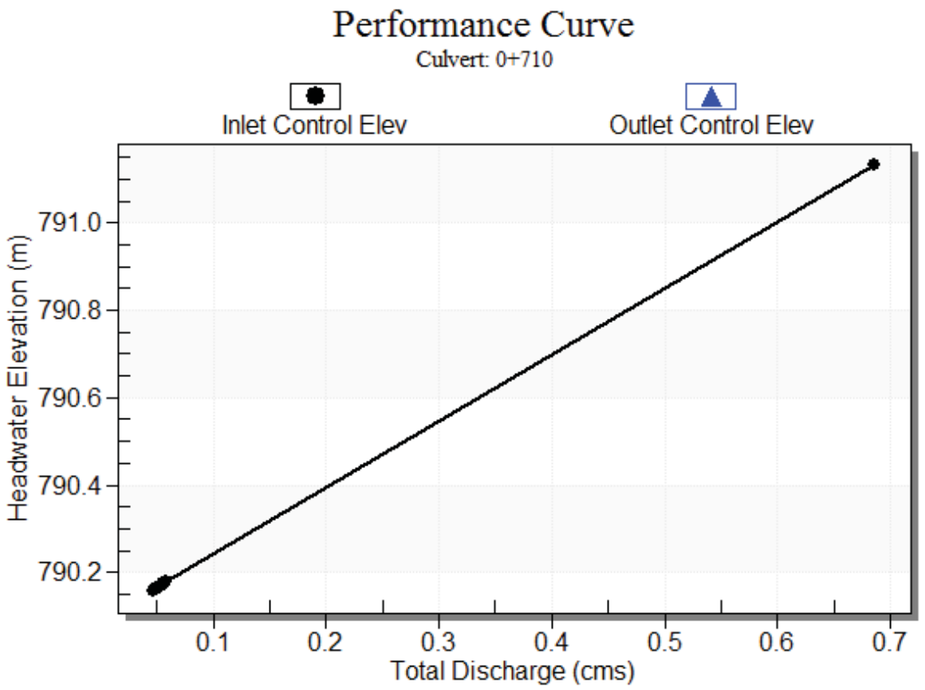
Culvert Length: 10.92 m, Culvert Slope: 0.0018

****

Water Surface Profile Plot for Culvert: 0+710



Culvert Performance Curve Plot: 0+710

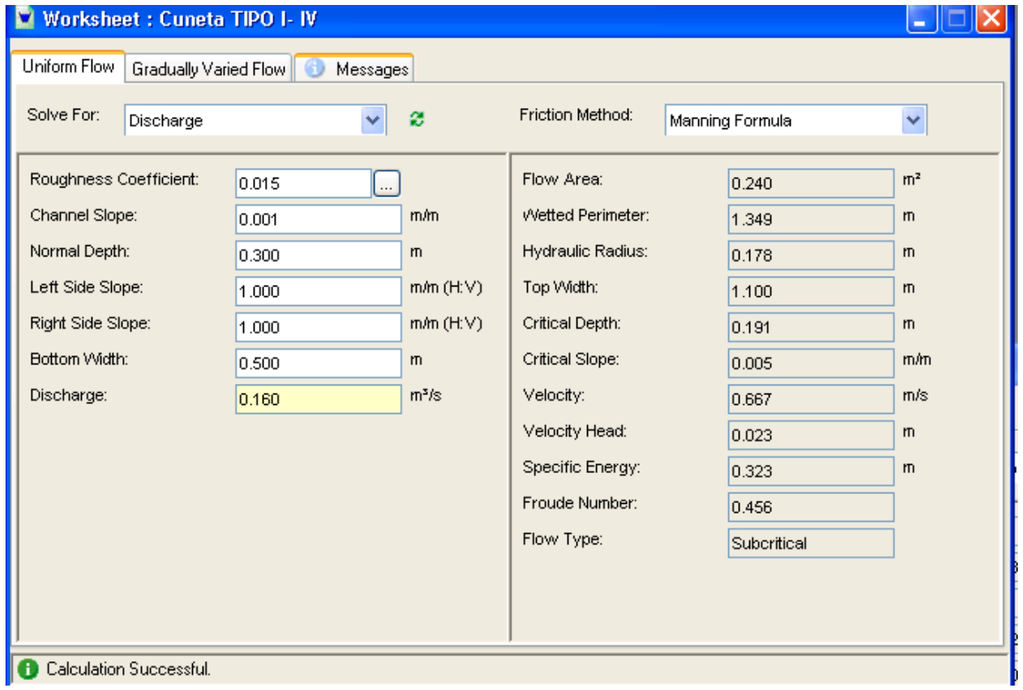


APÉNDICE 3

RESULTADO CÁLCULOS CUNETAS

RESULTADOS FLOWMASTER:

- *CUNETA TIPO I*



Rating Curve for Cuneta TIPO I- IV

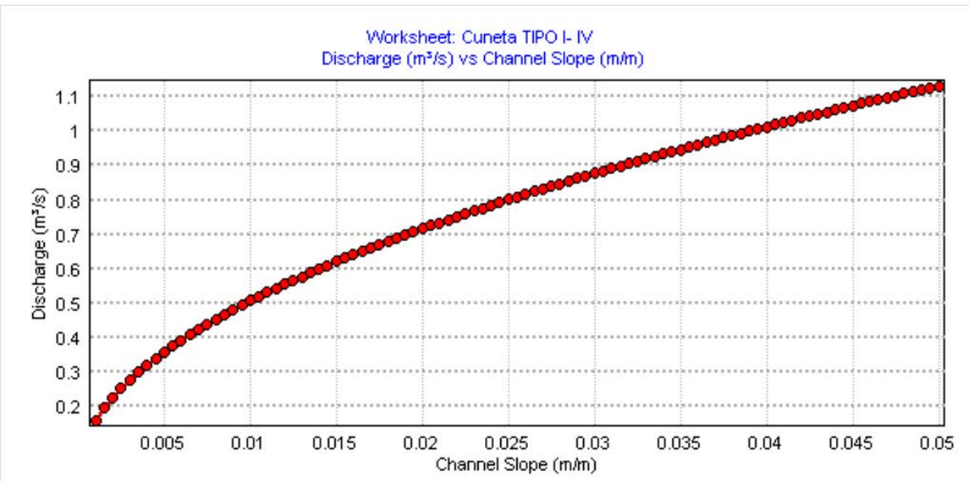
Project Description

Friction Method	Manning Formula
Solve For	Discharge

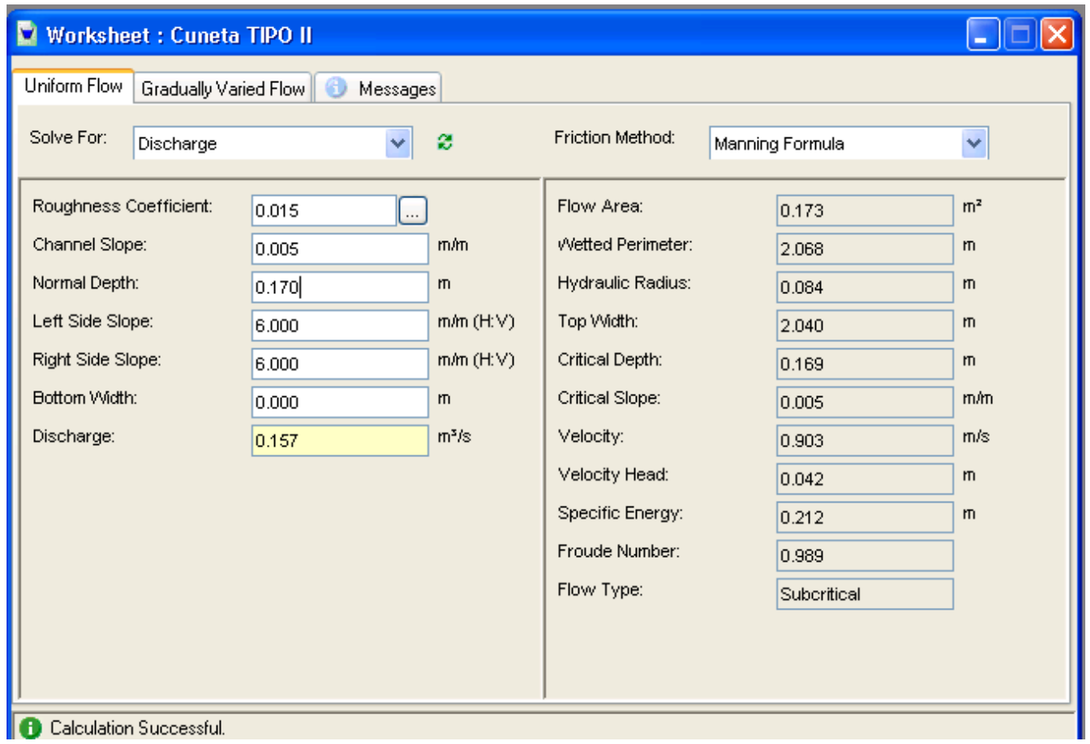
Input Data

Roughness Coefficient	0.015	
Channel Slope	0.001	m/m
Normal Depth	0.300	m
Left Side Slope	1.000	m/m (H:V)
Right Side Slope	1.000	m/m (H:V)
Bottom Width	0.500	m

Rating Curve Plot



- *CUNETA TIPO II*



Rating Curve for Cuneta TIPO II

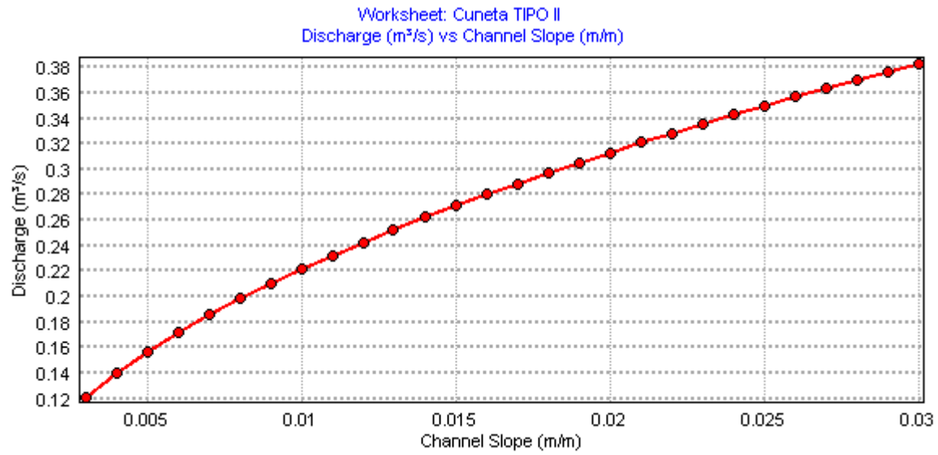
Project Description

Friction Method	Manning Formula
Solve For	Discharge

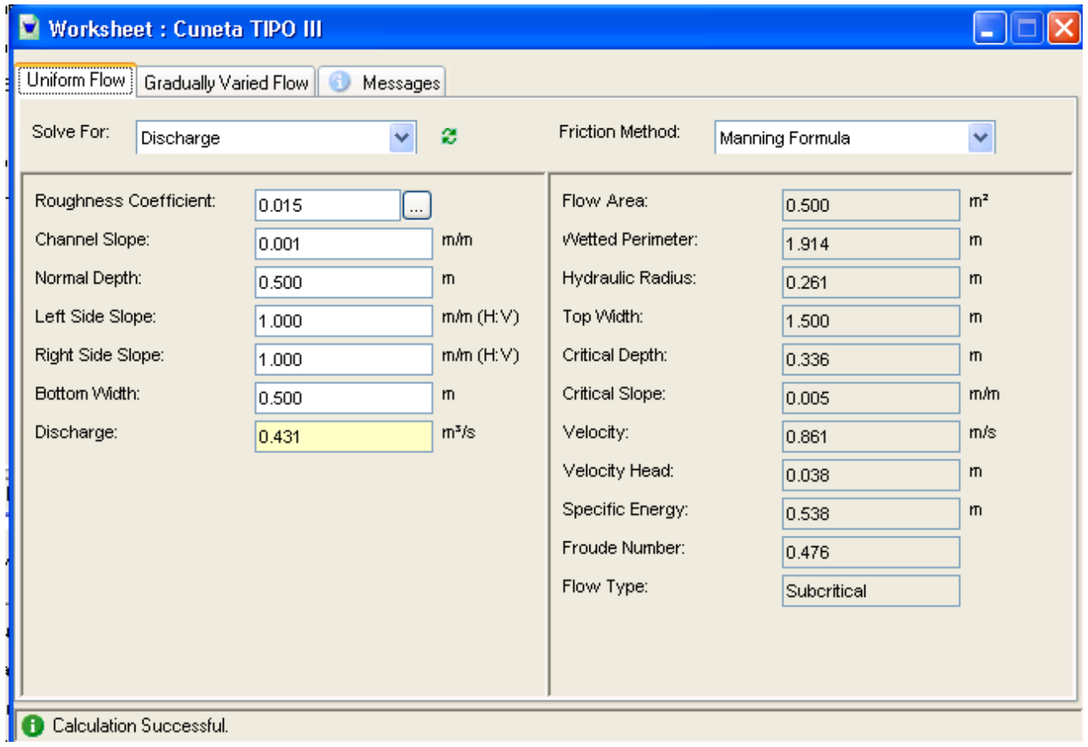
Input Data

Roughness Coefficient	0.015	
Channel Slope	0.005	m/m
Normal Depth	0.170	m
Left Side Slope	6.000	m/m (H:V)
Right Side Slope	6.000	m/m (H:V)
Bottom Width	0.000	m

Rating Curve Plot



- *CUNETA TIPO III*



Rating Curve for Cuneta TIPO III

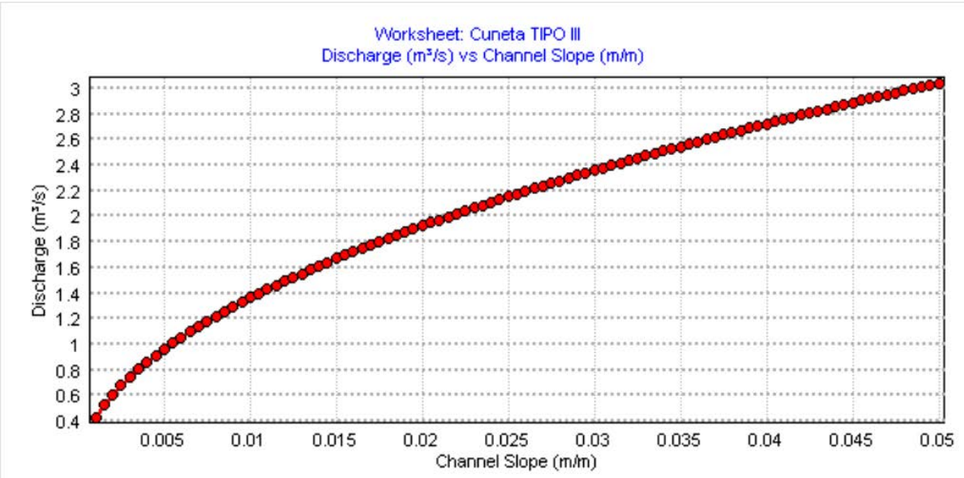
Project Description

Friction Method	Manning Formula
Solve For	Discharge

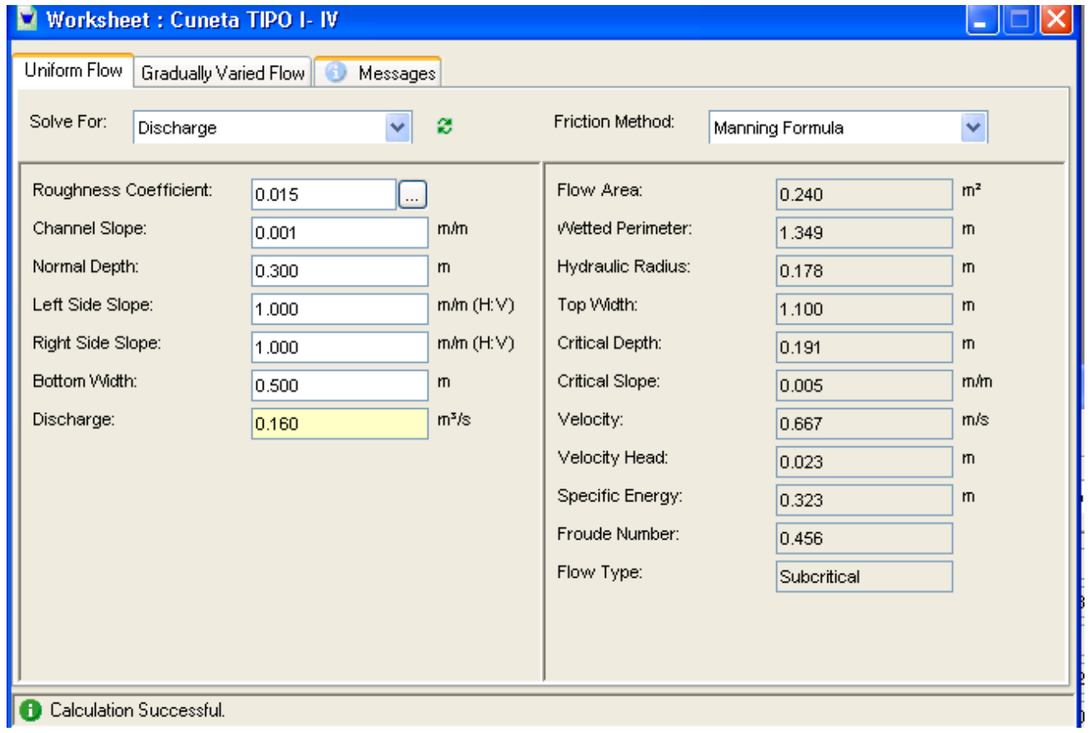
Input Data

Roughness Coefficient	0.015	
Channel Slope	0.001	m/m
Normal Depth	0.500	m
Left Side Slope	1.000	m/m (H:V)
Right Side Slope	1.000	m/m (H:V)
Bottom Width	0.500	m

Rating Curve Plot



- *<u>CUNETA TIPO IV</u>*

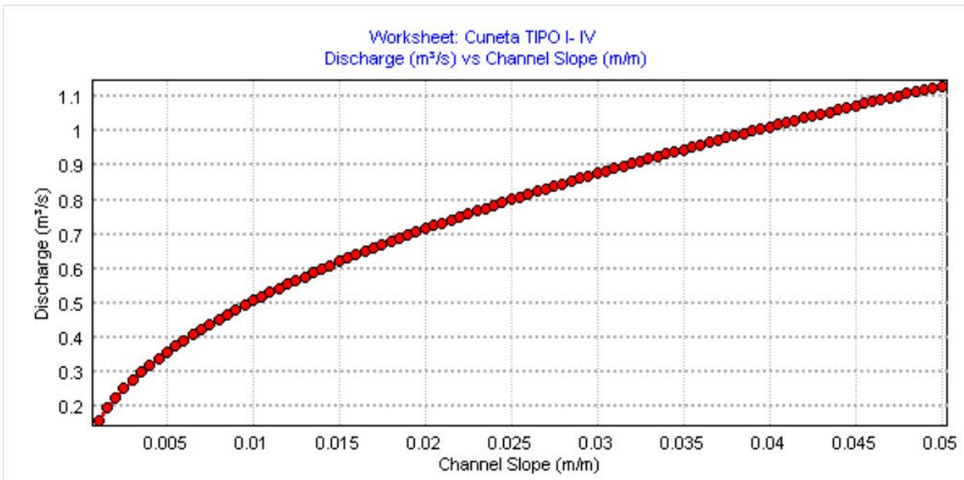


Rating Curve for Cuneta TIPO I- IV

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.001	m/m
Normal Depth	0.300	m
Left Side Slope	1.000	m/m (H:V)
Right Side Slope	1.000	m/m (H:V)
Bottom Width	0.500	m

Rating Curve Plot