BRITISH COLUMBIA

Ministry of Forests, Lands & Natural Resource Operations

ENGINEERING BRANCH

STANDARD BRIDGE DRAWINGS

TERRASPAN® GRS ARCH™ STRUCTURE

DRAWING SCHEDULE			
DRAWING No. / MODEL TYPE	DESCRIPTION	REV.	DATE
STD-C-050-01	GENERAL NOTES - SHEET 1	1	JUNE 2015
STD-C-050-02	GENERAL NOTES - SHEET 2	1	JUNE 2015
STD-C-050-03	EXAMPLE PROFILE AND ELEVATION FOR PERMANENT RECONSTRUCTED STREAM CHANNEL TYPE INSTALLATION	1	JUNE 2015
STD-C-050-04	TYPICAL CROSS-SECTIONS FOR RECONSTRUCTED AND NATURAL STREAM CHANNEL TYPE INSTALLATIONS	1	JUNE 2015
STD-C-050-05	INLET AND OUTLET DETAILS	1	JUNE 2015

CONCEPT DRAWINGS ONLY - NOT FOR CONSTRUCTION

ASSUME NOT TO SCALE

1. DESIGN CONCEPT

1.1 **DESCRIPTION:** THE TERRASPAN® GRS ARCH™ STRUCTURE (HEREIN AFTER REFERRED TO AS "THE STRUCTURE") IS A PROPRIETARY PRODUCT PROTECTED BY BOTH CANADIAN AND US PATENTS OWNED BY TERRATECH CONSULTING LTD. THE "PATENTED" INVENTION ASPECT OF THE STRUCTURE DESCRIBED IN THESE CONCEPTUAL DRAWINGS PERTAINS TO AN INNOVATIVE USE OF GEOTEXTILE REINFORCED SOIL (GRS) TECHNOLOGY TO CONSTRUCT A REINFORCED SOIL ARCH.

- THE INVENTION UTILIZES GRS TECHNOLOGY TO BUILD A GRS COMPOSITE MASS IN THE SHAPE OF AN "ARCH" USING A COMBINATION OF ALTERNATING THINLY SPACED LAYERS OF COMPACTED GRANULAR SOIL MATERIAL AND GEOTEXTILE FABRIC REINFORCEMENT IN A MANNER SO THAT THE REINFORCED SOIL ARCH ITSELF CAN SUPPORT THE DEAD LOAD AND LIVE LOAD. AN IMPORTANT FEATURE OF THE INVENTION IS THAT NO RIGID FOOTING (E.G., CONCRETE OR STEEL STRIP FOOTING) IS REQUIRED TO SUPPORT THE BASE OF THE METAL ARCH FORM.

1 • THE CONSTRUCTION OF THE REINFORCED SOIL ARCH FOR THE STRUCTURE REQUIRES THE USE OF AN ARCH SHAPED METAL FORM (TYPICALLY CORRUGATED STEEL PIPE, STRUCTURAL PLATE, DEEP OR ULTRADEEP STRUCTURAL PLATE) TO PRIMARILY AID IN THE CONSTRUCTION OF THE SOIL ARCH, BUT ALSO TO PROVIDE CONFINEMENT FOR THE SOIL AND TO PREVENT RAVELING OF THE SOIL FOLLOWING CONSTRUCTION. THE METAL FORM IS USED PRIMARILY FOR THE PURPOSE OF CONSTRUCTING THE SOIL ARCH AND IS A SECONDARY LOAD CARRYING ELEMENT OF THE STRUCTURE.

- FOR CLARIFICATION PURPOSES, THE PATENT DOES NOT INCLUDE GRS TECHNOLOGY. ADDITIONALLY, THE PATENT DOES NOT INCLUDE THE DESIGN AND CONSTRUCTION OF THE GRS FACING DETAILS (INCLUDING WELDED WIRE MESH FORMS) FOR RETAINED WALLS OR REINFORCED SOIL SLOPES AT THE INLET AND OUTLET ENDS OF THE STRUCTURE, OR OTHER SUCH DETAILS SHOWN ON THE DRAWINGS.

1.2 **INTENDED STRUCTURE USEAGE:** THE GRS ARCH™ STRUCTURE IS A MINISTRY APPROVED ALTERNATIVE TO OTHER TYPES OF CONVENTIONAL BURIED OPEN BOTTOM CROSSING STRUCTURES IN USE THAT SPAN THE ENTIRE STREAM CHANNEL. THE STRUCTURE MAY BE CONSIDERED ON A FOREST SERVICE ROAD (FSR) FOR RECONSTRUCTED STREAM CHANNEL CROSSING INSTALLATIONS (TO REPLACE AN EXISTING OPEN OR CLOSED BOTTOM CULVERT), OR FOR NEW NATURAL STREAM CHANNEL CROSSING INSTALLATIONS WHERE IT IS PRACTICABLE TO CLEAR SPAN THE STREAM CHANNEL WHILE LIMITING DISTURBANCE TO THE CHANNEL BANKS, AS DEPICTED IN STD-C-050-04.

2. DEFINITIONS

2.1 **DESIGN ENGINEER:** A PROFESSIONAL GEOTECHNICAL ENGINEER REGISTERED TO PRACTICE IN THE PROVINCE OF BRITISH COLUMBIA, EXPERIENCED IN THE DESIGN OF FOUNDATIONS, RETAINING WALLS, MAJOR CULVERTS, AND GRS STRUCTURES, RESPONSIBLE FOR ALL ASPECTS OF THE DETAILED DESIGN OF THE STRUCTURE (AND ASSURANCE OF CONSTRUCTION) IN CONFORMANCE WITH THESE CONCEPTUAL STANDARD DRAWINGS.

1 2.2 **COORDINATING REGISTERED PROFESSIONAL (CRP):** THE DESIGN ENGINEER MAY ACT AS THE CRP FOR THE PROJECT IF REQUESTED BY THE MINISTRY ENGINEER. THE CRP IS RESPONSIBLE FOR PLANNING AND COORDINATING ALL THE PROFESSIONAL SERVICES FOR THE CROSSING PROJECT INCLUDING THE DESIGN, FIELD REVIEWS, RECORD DRAWINGS AND *CRP CROSSING ASSURANCE STATEMENT*. THE CRP MUST DIRECT THOSE ACTIVITIES WITH SUFFICIENT OVERSIGHT AND SUPERVISION SUCH THAT THEY CAN TAKE OVERALL RESPONSIBILITY AND ACCOUNTABILITY FOR THE CROSSING.

1 2.3 **PROFESSIONAL OF RECORD (POR):** THE DESIGN ENGINEER SHALL BE THE POR RESPONSIBLE FOR PREPARATION OF CONSTRUCTION DRAWINGS, COMPLETION OF FIELD REVIEWS DURING CONSTRUCTION, AND COMPLETION OF THE *PROFESSIONAL OF RECORD CROSSING ASSURANCE STATEMENT* INCLUDING PREPARATION OF RECORD DRAWINGS.

2.4 **MINISTRY ENGINEER:** A PROFESSIONAL ENGINEER DESIGNATED BY THE MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS.

3. GENERAL

1 3.1 **DESIGN:** THE DESIGN ENGINEER WILL CARRY OUT THE DETAILED DESIGN OF THE STRUCTURE. THESE CONCEPTUAL STANDARD DRAWINGS ARE INTENDED TO PROVIDE THE BASIC ELEMENTS AND REQUIREMENTS FOR THE DETAILED DESIGN OF STRUCTURES WITH SPANS OF 8.3m OR LESS AS SHOWN ON STD-C-050-04, AND CONSTRUCTION OF HEADWALLS AND WINGWALLS THAT ARE LESS THAN 6m HIGH.

3.2 **DESIGN VARIATIONS:** VARIATIONS FROM THE STANDARD DRAWING REQUIREMENTS MAY BE ACCEPTABLE IN CERTAIN SPECIAL SITUATIONS. ALL SUCH VARIATIONS WILL BE DOCUMENTED AND REQUIRE APPROVAL FROM THE MINISTRY ENGINEER PRIOR TO COMPLETION OF FINAL DESIGN AND CONSTRUCTION.

1 3.3 **GEOTECHNICAL:** A GEOTECHNICAL FIELD ASSESSMENT IS REQUIRED TO DETERMINE THE LIKELY FOUNDATION CONDITIONS AND THE LOCATION OF POTENTIAL GRANULAR BORROW MATERIALS FOR THE CONSTRUCTION OF THE GRS COMPOSITE MASS AS WELL AS SOURCES OF RIPRAP FOR SCOUR PROTECTION AND OTHER ROCK NEEDED FOR STREAM CHANNEL RECONSTRUCTION AND FOUNDATION CONSTRUCTION, AS REQUIRED.

3.4 **HYDROLOGY:** EACH PROJECT SITE REQUIRES AN ANALYSIS OF FLUVIAL GEOMORPHOLOGY AND STREAM CHANNEL HYDROLOGY, WITH ESTIMATES OF DESIGN STREAM FLOWS AND SPECIFIC CRITERIA FOR SCOUR PROTECTION OF EACH INSTALLATION. THE DESIGN ENGINEER WILL ALSO CONSIDER IMPLICATIONS OF CLIMATE CHANGE FOR STRUCTURES INSTALLED ON PERMANENT TERM FSRS, AND WILL ASSESS INCREASED HYDROLOGICAL HAZARDS DUE TO PREDICTIONS OF MORE SEVERE RAINFALL INTENSITIES OR INCREASED FLOOD MAGNITUDE AND FREQUENCY OVER THE DESIGN SERVICE LIFE.

3.5 **TOPOGRAPHIC:** DETAILED TOPOGRAPHIC INFORMATION IS REQUIRED FOR ALL PROJECT SITES PRIOR TO DETAILED DESIGN.

3.6 **DESIGN DRAWINGS:** DETAILED DESIGN AND CONSTRUCTION DRAWINGS WILL GENERALLY CONSIST OF THE FOLLOWING DRAWING SET: (1) SITE CONDITIONS, SITE LOCATION, AND GENERAL NOTES; (2) SITE PLAN; (3) STRUCTURE PROFILE; (4) CROSS-SECTIONS AND DETAILS; (5) DEADMAN ANCHOR AND GEOTEXTILE FABRIC LAYOUT VIEWS AND DETAILS; (6) ELEVATION VIEWS FROM UPSTREAM AND DOWNSTREAM; (7) CONSTRUCTION GUIDELINES, AND NOTES FOR REQUIRED TOOLS AND EQUIPMENT AND LABOUR, AND MATERIAL ESTIMATES; (8) PHOTOS OF THE SITE; AND (9) EXAMPLE PHOTOS OF TYPICAL CONSTRUCTION PROCEDURES FOR A SIMILAR STRUCTURE INSTALLATION TO GUIDE CONSTRUCTION. ALL WORKING POINTS AND WORKING POINT ELEVATIONS NECESSARY FOR CONSTRUCTION WILL BE SHOWN ON THE DRAWINGS. ALL DIMENSIONS WILL BE IN METRIC. THE DESIGN DRAWINGS WILL CLEARLY SPECIFIY THE STRUCTURE NUMBER ASSIGNED BY THE MINISTRY ENGINEER.

3.7 **DESIGN DRAWING REQUIREMENTS:** THE DESIGN DRAWINGS MUST PORTRAY AND DESCRIBE ALL THE DRAWING REQUIREMENTS DESCRIBED IN SECTION 4.11.5 (MAJOR CULVERT DRAWING REQUIREMENTS) IN THE MINISTRY'S ENGINEERING MANUAL AVAILABLE AT: HTTP://WWW.FOR.GOV.BC.CA/HTH/ENGINEERING/DOCUMENTS/PUBLICATIONS_GUIDEBOOKS/MANUALS_STANDARDS/ENG-MANUAL.PDF

1 3.8 **ROAD PROFILE:** THE ROAD PROFILE WILL BE SHAPED TO SUIT THE CROSSING SITE AND ADJACENT ROAD REQUIREMENTS. THE DESIGN AND CONSTRUCTION OF THE ROAD PROFILE WILL ENSURE SUITABLE CONTROL OF ROAD SURFACE WATER RUNOFF. THE STRUCTURE WILL BE LOCATED AT CREST OF A VERTICAL CURVE OR ALONG SUSTAINED ROAD GRADE (GREATER THAN 1%) TO PREVENT THE PONDING OF ROAD SURFACE WATER ABOVE THE STRUCTURE AND MINIMIZE INFILTRATION OF SURFACE WATER INTO THE GRS COMPOSITE MASS. DO NOT LOCATE THE STRUCTURE IN THE BOTTOM OF SAG CURVES.

3.9 **VEHICLE OFF TRACKING:** WHERE REQUIRED, THE DESIGN ENGINEER WILL CONSIDER THE EFFECTS OF VEHICLE OFF TRACKING IN THE DESIGN OF THE HORIZONTAL ALIGNMENT AT THE STRUCTURE LOCATION (IN BOTH DIRECTIONS). THE DESIGN ENGINEER WILL OBTAIN THE VEHICLE OFF TRACKING DESIGN CRITERIA FROM THE MINISTRY ENGINEER.

1 3.10 **SEDIMENTATION CONTROL DURING CONSTRUCTION:** THE DESIGN WILL INCLUDE REQUIREMENTS FOR SEDIMENTATION CONTROL DURING CONSTRUCTION TO PROTECT THE ENVIRONMENT.

1 3.11 **CONSTRUCTION GUIDELINES:** THE DESIGN WILL INCLUDE CONSTRUCTION GUIDELINES THAT DETAIL THE REQUIREMENTS AND SEQUENCE OF CONSTRUCTION ACTIVITIES REQUIRED FOR COMPLETING THE STRUCTURE.

3.12 **REQUIRED TOOLS AND EQUIPMENT:** THE DESIGN DRAWINGS WILL INCLUDE A DETAILED LIST OF REQUIRED TOOLS, EQUIPMENT AND LABOUR TO CONSTRUCT THE STRUCTURE TO MINIMIZE THE POTENTIAL FOR CONSTRUCTION DELAYS AND INCREASED CONSTRUCTION COSTS.

3.13 **FISH PASSAGE**: ALL LEGISLATIVE REQUIREMENTS TO PROTECT FISH AND FISH HABITAT, AND TO PROVIDE FOR FISH PASSAGE, MUST BE MET.

4. DESIGN

4.1 **DESIGN SERVICE LIFE:** THE DESIGN DRAWINGS WILL CLEARLY SPECIFY THE DESIGN SERVICE LIFE OF THE STRUCTURE.

- MINIMUM DESIGN SERVICE LIFE OF "PERMANENT TERM" STRUCTURES (I.E., IN SERVICE FOR OVER 15 YEARS) IS 45 YEARS, OR GREATER AS REQUIRED BY THE MINISTRY ENGINEER.

- MINIMUM DESIGN SERVICE LIFE OF TEMPORARY TERM STRUCTURES (I.E., IN SERVICE FOR UP TO 15 YEARS) IS 25 YEARS.

1 4.2 **DESIGN VEHICLES:** THE DESIGN DRAWINGS WILL CLEARLY SPECIFY THE DESIGN VEHICLE THAT WAS USED FOR THE STRUCTURE DESIGN.

- REFER TO MINISTRY STANDARD BRIDGE DRAWINGS FOR STANDARD DESIGN VEHICLES.

- **MINIMUM** DESIGN VEHICLE LOADING SHALL BE BCL-625.

- **MAXIMUM** DESIGN VEHICLE LOADING SHALL BE BCFS L-100.

- HEAVIER DESIGN VEHICLE LOADING FOR BCFS L-150 OR BCFS L-165 CAN BE CONSIDERED PROVIDED THIS IS SUPPORTED AND VALIDATED BY FINITE DIFFERENCE OR FINITE ELEMENT ANALYSIS.

1 4.3 **DESIGN APPROACH:** THE PROCEDURES FOR DESIGN OF A GRS COMPOSITE MASS (FOR SPANS 8.3m OR LESS) TO RESULT IN A REINFORCED SOIL ARCH INCLUDE BOTH LIMIT EQUILIBRIUM AND LIMIT STATES DESIGN APPROACHES WHICH HAVE BEEN SHOWN TO BE CONSERVATIVE BASED ON THE ANALYSIS OF 6.6m, 8.3m AND LARGER SPAN STRUCTURES USING FINITE DIFFERENCE AND FINITE ELEMENT ANALYSIS. THE INTERNAL STRENGTH OF THE (1) GRS COMPOSITE MASS COMPONENT OF THE REINFORCED SOIL ARCH, AND (2) GRS WALLS OR GRS REINFORCED SOIL SLOPES AT THE INLET AND OUTLET ENDS OF THE STRUCTURE, IS CALCULATED BASED ON CHAPTER 4 OF "GEOSYNTHETIC REINFORCED SOIL INTEGRATED BRIDGE SYSTEM INTERIM IMPLEMENTATION GUIDE" PUBLICATION NO. FHWA-HRT-11-026, DATED JANUARY 2011.

4.4 **DESIGN SPANS:** DESIGN SPAN AND RISE WILL BE SELECTED TO SUIT THE FLUVIAL GEOMORPHOLOGY AND HYDROLOGY OF THE STREAM. IF THE STRUCTURE IS NOT LOCATED AT A STREAM CHANNEL, THE SPAN AND RISE OF THE STRUCTURE WILL BE SELECTED BASED ON OTHER CRITERIA UNIQUE TO THE SPECIFIC APPLICATION.

1 - PROPOSED STRUCTURE SPANS CAPTURED BY THESE DRAWINGS AND SPECIFICATIONS ARE LIMITED TO 8.3m OR LESS.

4.5 **SEISMIC DESIGN:** SEISMIC DESIGN NOT REQUIRED UNLESS OTHERWISE SPECIFIED.

4.6 **DESIGN OF FOUNDATIONS:** DEPENDING ON STREAM CHANNEL HYDROLOGY, NATURAL SOIL CONDITIONS AND OTHER SITE SPECIFIC CONSIDERATIONS, THE DESIGN ENGINEER WILL DETERMINE THE REQUIREMENTS OF FOUNDATION PREPARATION FOR THE GRS COMPOSITE MASS. TYPICALLY, THIS WILL REQUIRE SUB-EXCAVATING UNSUITABLE SOILS TO A SPECIFIED DEPTH AND BACKFILLING WITH A DESIGNED ROCK FILL TO THE UNDERSIDE OF THE GRS COMPOSITE MASS AS SHOWN ON STD-C-050-04. THE ROCK FILL WILL BE COMPRISED OF DURABLE AND APPROPRIATELY SIZED AND SHAPED ROCK WITH THICKNESS AND WIDTH DIMENSIONS SPECIFIED ON THE DESIGN DRAWINGS.

4.7 **DESIGN OF SCOUR PROTECTION:** SCOUR OR UNDERMINING OF THE FOUNDATIONS OF THE GRS COMPOSITE MASS IS A KEY DESIGN CONSIDERATION. SECURITY AGAINST SCOUR FAILURE WILL BE BUILT INTO THE DESIGN OF THE FOUNDATIONS (E.G., EMBEDDING THE FOUNDATIONS BELOW THE ANTICIPATED SCOUR DEPTH LEVEL OR OTHER SUITABLE MEASURE). THE DESIGN WILL ALSO PROVIDE FOR PLACEMENT OF RIPRAP SCOUR PROTECTION AGAINST (1) THE FACING OF THE INLET AND OUTLET ENDS OF THE STRUCTURE TO AN APPROPRIATE CONTINGENCY ELEVATION ABOVE THE DESIGN HIGH WATER LEVEL, AND (2) THE INTERIOR SIDES OF THE METAL ARCH FORM ALONG THE BASE. THE MINIMUM CONTINGENCY ELEVATION ABOVE THE DESIGN HIGH WATER LEVEL IS 0.5m AND 0.3m, AT THE UPSTREAM AND DOWNSTREAM ENDS, RESPECTIVELY. RIPRAP CAN BE DESIGNED IN ACCORDANCE WITH THE "FOREST SERVICE BRIDGE DESIGN AND CONSTRUCTION MANUAL" OR OTHER SIMILAR APPROPRIATE REFERENCE FOR DESIGN OF RIPRAP.

4.8 **DESIGN OF RECONSTRUCTED STREAM CHANNEL INSTALLATIONS:** FOR RECONSTRUCTED STREAM CHANNEL INSTALLATIONS (TO REPLACE AN EXISTING CULVERT), THE SPAN OF THE ARCH FORM IS TO BE TYPICALLY A MINIMUM OF 20 PERCENT MORE THAN THE NATURAL, REPRESENTATIVE STREAM CHANNEL WIDTH (SHOWN ON STD_C_050_04) AS DETERMINED BY AN ASSESSMENT OF THE STREAM CHANNEL UPSTREAM AND DOWNSTREAM OF THE CROSSING SITE, WHERE APPLICABLE. THE DESIGN OF THE RECONSTRUCTED STREAM CHANNEL BED WITHIN THE INTERIOR OF THE METAL ARCH FORM WILL INCLUDE A DESIGNED SUBSTRATE COMPRISED OF DURABLE AND APPROPRIATELY SIZED AND SHAPED ROCK (WITH VOIDS IN-FILLED WITH SAND AND GRAVEL) WITH THICKNESS AND WIDTH DIMENSIONS SPECIFIED ON THE DESIGN DRAWINGS. THE DESIGN DRAWINGS WILL SPECIFY THE CONSTRUCTION PROCEDURES (INCLUDING COMPACTION) TO RECONSTRUCT THE STREAM CHANNEL.

- THE DESIGN WIDTH OF THE RECONSTRUCTED STREAM CHANNEL WILL CONSIDER THE REQUIREMENT FOR RIPRAP PLACED AGAINST THE INTERIOR SIDES OF THE METAL ARCH FORM.

1 4.9 **DESIGN OF GRS COMPOSITE MASS:** THE DESIGN ENGINEER WILL SPECIFY AND APPROVE ALL BACKFILL SOILS USED TO BUILD THE GRS COMPOSITE MASS, INCLUDING THE DEGREE OF SOIL COMPACTION REQUIRED AND COMPACTION PROCEDURES. ONLY NON FROST SUSCEPTIBLE, GRANULAR AND FREE DRAINING SOILS WILL BE USED TO BUILD THE GRS COMPOSITE MASS, COMPACTED AS SPECIFIED AND IN LIFT THICKNESSES DETERMINED BY THE GEOTEXTILE FABRIC SPACING SHOWN ON THE DESIGN DRAWINGS. PROVIDE FOR ADEQUATE DRAINAGE OF THE GRS COMPOSITE MASS. THE DESIGN WILL INCLUDE MEASURES TO PREVENT THE REINFORCED SOIL ZONE BACKFILL FROM MIGRATING AND ESCAPING THROUGH ANY VOIDS OR GAPS IN THE FACING ELEMENTS.

- THE MAXIMUM VERTICAL SPACING OF LAYERED GEOTEXTILE SOIL REINFORCEMENT WILL BE SHOWN ON THE DESIGN DRAWNGS AND WILL NOT EXCEED 0.3m .

- EXCEPT AS NOTED, ONLY WOVEN GEOTEXTILE FABRIC WILL BE USED AS REINFORCEMENT TO CONSTRUCT THE GRS COMPOSITE MASS. HOWEVER, DEPENDING UPON DETAILED SITE SPECIFIC CONSIDERATIONS AND IF SPECIFIED BY THE DESIGN ENGINEER, THE BOTTOM TWO LAYERS OF GEOTEXTILE FABRIC REINFORCEMENT, AS WELL AS GEOTEXTILE FABRIC REQUIRED FOR SEPARATION AND REINFORCEMENT IN FOUNDATION PREPARATION MAY BE NON-WOVEN.

1 - FREEZING OF SATURATED BACKFILL SOILS ADJACENT TO THE METAL ARCH FORM CAN RESULT IN SOIL EXPANSION AND FORCES IN THE ANCHORS WHICH EXCEED THE CAPACITY OF THE BARS OR THE CONNECTION BETWEEN THE ANCHOR BARS AND THE METAL ARCH FORM. ACCORDINGLY IN ADDITION TO THE REQUIRED CONTROL OF ROAD SURFACE RUNOFF WATER BY PROPER CONSTRUCTION OF THE ROAD PROFILE (SEE CLAUSE 3.8) TO MINIMIZE SURFACE WATER INFILTRATION INTO THE BACKFILL SOILS, THE DESIGN MUST INCLUDE PROVISIONS TO PRECLUDE POTENTIAL ADVERSE EFFECTS ASSOCIATED WITH THE FREEZING OF SATURATED SOILS ADJACENT TO THE METAL ARCH FORM, INCLUDING BUT NOT LIMITED TO SPECIFYING SUITABLE FREE-DRAINING GRANULAR BACKFILL SOILS AND INCORPORATING ADEQUATE DRAINAGE SYSTEMS TO PREVENT SATURATION OF THE BACKFILL.

CONCEPT DRAWINGS ONLY - NOT FOR CONSTRUCTION

ASSUME NOT TO SCALE

Province of British Columbia
MINISTRY OF FOREST, LANDS AND NATURAL RESOURCE OPERATIONS
ENGINEERING BRANCH

SCALE AS SHOWN

Designed CVB Date JULY2011
Checked CVB Date JULY2011
Drawn HM Date JULY2011

Rev	Date	DESCRIPTION	Init	
1	June 2015	Text Edits	HM	

REVISIONS

STANDARD BRIDGE DRAWING

Terraspan® GRS Arch™ Structure–Conceptual Only

General Notes – Sheet 1

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DRAWING No. STD–C–050–01 1

CANCEL PRINTS BEARING PREVIOUS NUMBER

4.10 **ASSEMBLY OF METAL ARCH FORM:** THE DESIGN ENGINEER WILL ENSURE THAT THE ASSEMBLY DETAIL FOR THE METAL ARCH FORM (PROVIDED BY THE MANUFACTURER) WILL BE SUPPLIED WITH THE MATERIALS AND/OR THE DESIGN DRAWINGS. THE BOTTOM EDGES OF THE METAL ARCH FORM MUST BE FITTED WITH EITHER A METAL CHANNEL OR ANGLE TO PREVENT CONCENTRATED STRESSES ALONG THE THIN METAL EDGE OF THE FORM.

4.11 **DEADMAN ANCHORS:** THE DEADMAN ANCHORS ARE PRIMARILY DESIGNED TO SECURE THE METAL ARCH FORM TO THE GRS COMPOSITE MASS AND TO RESIST CONSTRUCTION LOADING. ALTHOUGH THE NEEDED TENSILE CAPACITY OF THE ANCHORS IS NOMINAL, THEY MUST BE DESIGNED TO FUNCTION FOR THE DESIGN SERVICE LIFE OF THE STRUCTURE AS THEY ARE A SECONDARY LOAD CARRYING ELEMENT. THE DESIGN DRAWINGS MUST INCLUDE ANCHOR DETAILS AND MATERIAL SPECIFICATIONS INCLUDING REQUIREMENTS FOR CORROSION PROTECTION. ANCHOR LAYOUT AND INSTALLATION DETAILS WILL BE SHOWN ON THE DESIGN DRAWINGS.

4.12 **CONSTRUCTION LOAD:** THE DESIGN ENGINEER MUST CONSIDER THE WEIGHT OF MATERIALS, WORK CREWS AND EQUIPMENT SUPPORTED DURING CONSTRUCTION WHEN DESIGNING THE STRUCTURE. THE DESIGN ENGINEER MUST SPECIFY MAXIMUM PERMISSIBLE CONSTRUCTION EQUIPMENT LOADS AND CONSTRUCTION SEQUENCE ON THE DETAILED DESIGN AND CONSTRUCTION DRAWINGS, AS REQUIRED TO ADDRESS WORKER SAFETY DURING CONSTRUCTION.

5. FIELD REVIEWS DURING CONSTRUCTION

5.1 **FIELD REVIEWS:** THE PROFESSIONAL OF RECORD **(POR)**, OR THE **POR'S** DESIGNATE ACTING UNDER THE DIRECT SUPERVISION OF THE **POR**, WILL CONDUCT THE NECESSARY CONSTRUCTION FIELD REVIEWS REQUIRED TO PROVIDE ASSURANCE THAT THE STRUCTURE IS CONSTRUCTED IN GENERAL CONFORMANCE WITH THE DESIGN DRAWINGS.

THE **POR**, OR THE **POR'S** DESIGNATE ACTING UNDER THE DIRECT SUPERVISION OF THE **POR**, MUST BE ON-SITE FOR REVIEW AND APPROVAL OF CONSTRUCTION PROCEDURES, VERIFICATION OF MATERIALS USED IN CONSTRUCTION, AND FOUNDATION PREPARATION.

NOTE: PERMITS FROM OTHER REGULATORY AGENCIES MAY BE REQUIRED AS DETERMINED BY THE COORDINATING REGISTERED PROFESSIONAL (CRP).

THE **POR** WILL BE RESPONSIBLE FOR THE FOLLOWING TASKS:

- DOCUMENT ALL FIELD PRESCRIBED MEASURES OR VARIATIONS FROM THE DESIGN DRAWINGS IN THE *PROFESSIONAL OF RECORD CROSSING ASSURANCE STATEMENT* .
- APPROVE AND DOCUMENT ALL SOURCES OF SOIL MATERIALS USED TO BUILD THE GRS COMPOSITE MASS, AND ALL SOURCES OF ROCK MATERIALS FOR RIPRAP, FOUNDATION PREPARATION AND CHANNEL RECONSTRUCTION, PRIOR TO SOURCE DEVELOPMENT.
- DOCUMENT THE TYPES OF SOIL MATERIALS USED TO BUILD THE GRS COMPOSITE MASS, AND THE SIZE AND TYPE OF ALL ROCK PLACED FOR RIPRAP, THE FOUNDATION PREPARATION AND CHANNEL RECONSTRUCTION.
- OBTAIN ALL MILL TEST CERTIFICATES FOR THE GEOTEXTILE FABRIC, METAL ARCH FORM, (DEADMAN ANCHORS IF AVAILABLE), AND WELDED WIRE MESH FORMS, INCORPORATED INTO THE STRUCTURE.
- DOCUMENT THE TYPE, SIZE, GRADE OF STEEL, AND MANUFACTURER OF DEADMAN ANCHORS USED.

5.2 CONSTRUCTION DOCUMENTATION SHOULD INCLUDE ASSEMBLED SHAPE MEASUREMENTS (CORDS) AND POST CONSTRUCTION CORD MEASUREMENTS AT A MINIMUM OF THREE LOCATIONS ALONG THE LENGTH OF THE STRUCTURE. A MINIMUM OF THREE CORD MEASUREMENTS (INCLUDING THE SPAN) SHOULD BE RECORDED AT EACH LOCATION. IN ADDITION, AT BOTH THE INLET AND OUTLET ENDS, THE ELEVATIONS OF THE BOTTOM EDGES AND CROWN OF THE METAL ARCH FORM SHOULD BE RECORDED AND REFERENCED TO PERMANENT SITE BENCHMARKS.

6. INLET AND OUTLET DETAILS

6.1 **CONSIDERATIONS IN SELECTION OF INLET AND OUTLET DETAILS:** THE CONFIGURATION OF THE INLET AND OUTLET ENDS OF THE STRUCTURE MAY INCLUDE RETAINED WALLS OR REINFORCED SOIL SLOPES, OR A COMBINATION OF THESE TWO OPTIONS. THE SELECTION OF INLET AND OUTLET DETAILS (I.E., CONFIGURATION OF THE INLET AND OUTLET ENDS OF THE STRUCTURE AND ASSOCIATED FACING OPTIONS) MUST CONSIDER VARIOUS FACTORS TO ADDRESS DURABILITY, SERVICEABILITY AND OTHER DESIGN OBJECTIVES, INCLUDING BUT NOT LIMITED TO THE FOLLOWING:

- DESIGN SERVICE LIFE
- ECONOMIC IMPLICATIONS OF THE STRUCTURE LENGTH AND POTENTIAL ENVIRONMENTAL IMPACT
- ROAD SAFETY CONSIDERATIONS AND TRAFFIC BARRICADE REQUIREMENTS
- LIFE CYCLE COST CONSIDERATIONS, FUTURE MAINTENANCE AND SERVICEABILITY
- DRAINAGE REQUIREMENTS FOR THE GRS COMPOSITE MASS
- DURABILITY FOR GIVEN EXPOSURE
- TOLERANCES TO MOVEMENT DURING AND AFTER CONSTRUCTION SETTLEMENT, DEFLECTION, AND ROTATION
- EXPOSURE OF UNCOVERED GEOTEXTILE MATERIALS TO POTENTIALLY DELETERIOUS ENVIRONMENTAL FACTORS SUCH AS THE LONG-TERM EFFECTS OF ULTRAVIOLET (UV) LIGHT
- LIKELIHOOD OF POSSIBLE DAMAGE TO FACING ELEMENTS FROM STREAM ABRASION AND SCOUR HAZARDS
- LIKELIHOOD OF POSSIBLE DAMAGE FROM GRADING AND SNOW REMOVAL OPERATIONS AND VANDALISM
- AESTHETICS
- ANTICIPATED POTENTIAL FUTURE TRANSFER OF THE FSR TO OTHER AGENCIES POSSIBLY NECESSITATING THE INSTALLATION OF SPECIFIC MATERIALS FOR FACING ELEMENTS
- AVAILABILITY OF MATERIALS
- HORIZONTAL ALIGNMENT RESTRICTIONS AND SPACE LIMITATIONS.

6.2 **MINISTRY APPROVAL:** THE MINISTRY ENGINEER MUST APPROVE THE FACING ELEMENT TYPE FOR THE INLET AND OUTLET ENDS OF THE ARCH PRIOR TO FINAL DESIGN AND CONSTRUCTION.

6.3 **RETAINED HEADWALLS AND WINGWALLS FOR INLET AND OUTLET ENDS:**

- **CONFIGURATION OF WALLS:** THE INLET AND OUTLET ENDS OF THE STRUCTURE MAY BE CONSTRUCTED AS RETAINED HEADWALLS AND WINGWALLS WITH SLOPE GRADIENTS EQUAL TO OR STEEPER THAN 2 VERTICAL TO 1 HORIZONTAL (63 DEGREES) BY UTILIZING THE BIAXIAL NATURE AND STABILITY OF THE LAYERED GEOTEXTILE SOIL REINFORCEMENT THAT IS USED TO CONSTRUCT THE ARCH. THIS CONFIGURATION MAY BE SUITABLE FOR STRUCTURES INSTALLED ON EITHER TEMPORARY TERM OR PERMANENT TERM FSRS WITH APPROPRIATE RIPRAP SCOUR PROTECTION WHERE REQUIRED AT THE BASE OF THE WALL. THE WALLS ARE CONSTRUCTED USING A FACING ELEMENT THAT SERVES AS A CONSTRUCTION AID, AND PROTECTS THE GRANULAR FILL OF THE GRS COMPOSITE MASS FROM OUTSIDE WEATHERING, EROSION AND RAVELLING. THE WALL FACING ELEMENT IS NOT A STRUCTURAL MEMBER OF THE STRUCTURE.

- **DURABLE MATERIALS AT THE FACE:** UNLESS OTHERWISE SPECIFIED OR APPROVED BY THE MINISTRY ENGINEER, THE FACING ELEMENTS FOR RETAINED HEADWALLS AND WINGWALLS WILL BE COMPRISED OF DURABLE MATERIALS SUCH AS ROCK FILL (COBBLES, OR BROKEN ROCK), OR GALVANIZED STEEL SHEETS, INCORPORATED WITH GALVANIZED WELDED WIRE MESH FORMS. FOR ROCK FILL FACING, THE DESIGN WILL SPECIFY ADEQUATELY SIZED ROCK TO PREVENT THE LOSS OF COBBLES OR BROKEN ROCK THROUGH THE GRID OPENINGS IN THE WELDED WIRE MESH FORMS. THE USE OF DURABLE FACING MATERIALS IS REQUIRED FOR RETAINED HEADWALLS AND WINGWALLS FOR STRUCTURES INSTALLED ON PERMANENT TERM FSRS.

- **DOUBLE LAYERED GEOTEXTILE FABRIC AT THE FACE:** SUBJECT TO APPROVAL BY THE MINISTRY ENGINEER, THE FACING ELEMENT OF RETAINED HEADWALLS AND WINGWALLS MAY CONSIST OF A DOUBLE LAYER OF GEOTEXTILE FABRIC AT THE FRONT OF GALVANIZED WELDED WIRE MESH FORMS PROVIDED THE DESIGN ENGINEER HAS DETERMINED (AFTER CONSIDERATION OF THE SITE SPECIFIC UV POTENTIAL) THAT THIS DOUBLE LAYER SYSTEM OF GEOTEXTILE FABRIC WILL PROVIDE SUITABLE UV PROTECTION TO MEET PROJECT DURABILITY AND SERVICEABILITY REQUIREMENTS OVER THE DESIGN SERVICE LIFE. THE GEOTEXTILE FABRIC MUST BE UV STABILIZED USING CARBON BLACK MEETING THE FOLLOWING MINIMUM SPECIFICATION: MINIMUM 70 PERCENT STRENGTH RETAINED AFTER 500 HRS OF UV EXPOSURE ACCORDING TO ASTM D4355 - "STANDARD TEST METHOD FOR DETERIORATION OF GEOTEXTILES BY EXPOSURE TO LIGHT, MOISTURE AND HEAT IN A XENON ARC TYPE APPARATUS." THE POSSIBLE USE OF DOUBLE LAYERED GEOTEXTILE FABRIC SHOULD ONLY BE CONSIDERED FOR RETAINED HEADWALLS AND WINGWALLS ON STRUCTURES INSTALLED ON TEMPORARY TERM FSRS AFTER CONSIDERATION OF THE FACTORS LISTED IN SECTION 6.1 AND CONSULTATION WITH THE MINISTRY ENGINEER.

6.4 **REINFORCED SOIL SLOPES FOR INLET AND OUTLET ENDS:**

- **CONFIGURATION OF REINFORCED SOIL SLOPES:** THE INLET AND OUTLET ENDS OF THE STRUCTURE MAY ALSO BE CONSTRUCTED AS AN EMBANKMENT OR OVERSTEEPENED SLOPE WITH SLOPE GRADIENTS LESS THAN 2 VERTICAL TO 1 HORIZONTAL (63 DEGREES) UTILIZING THE BIAXIAL NATURE AND STABILITY OF THE LAYERED GEOTEXTILE SOIL REINFORCEMENT THAT IS USED TO CONSTRUCT THE ARCH. A FACING ELEMENT COMBINING (1) GALVANIZED WELDED WIRE MESH FORMS, GEOTEXTILE AND VEGETATION; OR (2) STACKED ROCK WITH GEOTEXTILE SEPARATION, IS USED FOR THIS CONFIGURATION. THIS CONFIGURATION MAY BE SUITABLE FOR STRUCTURES INSTALLED ON EITHER TEMPORARY TERM OR PERMANENT TERM FSRS WITH APPROPRIATE RIPRAP SCOUR PROTECTION WHERE REQUIRED AT THE BASE OF THE SLOPE.

- **VEGETATION AT THE FACE:** SUBJECT TO APPROVAL BY THE MINISTRY ENGINEER, AND FOR REINFORCED SOIL SLOPES OF HEADWALLS AND WINGWALLS WITH SLOPES OF LESS THAN 2 VERTICAL TO 1 HORIZONTAL (63 DEGREES), THE FACING ELEMENT MAY CONSIST OF A VEGETATED WALL FACE, UTILIZING GALVANIZED WELDED WIRE MESH FORMS AND A SINGLE LAYER OF GEOTEXTLE FABRIC AT THE FACE. TO ACHIEVE THE VEGETATED FACE, GRASS SEEDING AND/OR LIVE STAKING WILL BE INCORPORATED INTO THE DESIGN. THE PROCEDURES AND MATERIALS FOR SEEDING AND LIVE STAKING WILL BE SPECIFIED ON THE DESIGN DRAWINGS, BASED ON CONSIDERATIONS OF CLIMATE, EXPOSURE ASPECT, ROAD GEOMETRY AND OTHER SITE CONDITIONS.

- **STACKED ROCK AT THE FACE:** SUBJECT TO APPROVAL BY THE MINISTRY ENGINEER, STACKED ROCK FOR REINFORCED SOIL SLOPES OF HEADWALLS AND WINGWALLS WITH GEOTEXTILE SEPARATION MAY BE USED FOR EMBANKMENT HEIGHTS OF LESS THAN 4m HIGH AND SLOPING AT LESS THAN 2 VERTICAL TO 1 HORIZONTAL (63 DEGREES). THE DESIGN WILL SPECIFY THAT ONLY DURABLE ROCK OF SUITABLE SIZE AND SHAPE TO ACHIEVE A STABLE FACE WILL BE USED.

7. MATERIALS

7.1 **WOVEN GEOTEXTILE FABRIC FOR SOIL REINFORCEMENT:** WOVEN GEOTEXTILE FABRICS USED TO CONSTRUCT THE GRS COMPOSITE MASS WILL MEET THE FOLLOWING MINIMUM DESIGN CRITERIA:

- MINIMUM WIDE-WIDTH TENSILE STRENGTH OF 30kN/m (ASTM D4595 - "STANDARD TEST METHOD FOR TENSILE PROPERTIES OF GEOTEXTILES BY THE WIDE-WIDTH STRIP METHOD").

7.2 **NON-WOVEN GEOTEXTILE FABRIC (IF SPECIFIED):** NON-WOVEN GEOTEXTILE FABRICS, WHERE PERMITTED, WILL MEET THE FOLLOWING MINIMUM DESIGN CRITERIA:

- GRAB TENSILE STRENGTH OF 890N (ASTM D4632 - "STANDARD TEST METHOD FOR GRAB BREAKING LOAD AND ELONGATION OF GEOTEXTILES")

- PUNCTURE STRENGTH 580N (ASTM D4833 - "STANDARD TEST METHOD FOR INDEX PUNCTURE RESISTANCE OF GEOMEMBRANES AND RELATED PRODUCTS").

7.3 **METAL ARCH FORM, CHANNEL OR ANGLE, AND STRUCTURAL BOLTS FOR CONNECTIONS:** THE METAL ARCH FORM, AND CHANNEL OR ANGLE AFFIXED ALONG BOTTOM EDGES OF THE METAL ARCH FORM, USED TO CONSTRUCT THE GRS ARCH™ WILL CONSIST OF COMPONENTS MANUFACTURED IN ACCORDANCE TO CAN/CSA-G401 - "CORRUGATED STEEL PIPE PRODUCTS." SMALL LOCALIZED SCRATCHES GREATER THAN 3mm WIDE, OR BURNS CAUSED BY WELDING, NOT INCLUDING CUT EDGES, WHERE THE GALVANIZED COATING HAS BEEN DAMAGED WILL BE REPAIRED BY CLEANING AND THE APPLICATION OF A ZINC-RICH COATING IN ACCORDANCE WITH CAN/CGSB-1.181 - "READY-MIXED ORGANIC ZINC-RICH COATING."

7.4 **DEADMAN ANCHORS AND ASSOCIATED HARDWARE:** THE DEADMAN ANCHORS AND ALL ASSOCIATED HARDWARE MUST BE PROVIDED WITH CORROSION PROTECTION. THIS CAN BE ADDRESSED BY THE METHOD OF APPLYING A SUITABLE HOT DIPPED GALVANIZED COATING TO THE ENTIRE ANCHOR ASSEMBLY TO CSA-G164 - "HOT DIP GALVANIZING OF IRREGULARLY SHAPED ARTICLES" (ASTM 123 - "STANDARD SPECIFICATION FOR ZINC (HOT-DIP GALVANIZED) COATINGS ON IRON AND STEEL PRODUCTS"). THE DESIGN DRAWINGS MUST SPECIFY THE METHOD OF CORROSION PROTECTION USED AND ALL REQUIRED COATINGS IF APPLICABLE.

7.5 **WELDED WIRE MESH FORMS AND ASSOCIATED STEEL STRUTS AND HARDWARE:**

- WELDED WIRE MESH TO BE FABRICATED USING MINIMUM 4 GAUGE WIRE MANUFACTURED IN ACCORDANCE WITH ASTM A1064 - "STANDARD SPECIFICATION FOR CARBON-STEEL WIRE AND WELDED WIRE REINFORCEMENT, PLAIN AND DEFORMED, FOR CONCRETE"

- WELDED WIRE MESH TO BE FABRICATED IN ACCORDANCE WITH ASTM A1064 AND GALVANIZED TO ASTM A123"

- STEEL STRUTS TO BE FABRICATED WITH A MINIMUM 4 GAUGE WIRE MANUFACTURED IN ACCORDANCE WITH ASTM A1064 AND ZINC COATED IN ACCORDANCE WITH ASTM A641 - "STANDARD SPECIFICATION FOR ZINC-COATED (GALVANIZED) CARBON STEEL WIRE"

7.6 **MATERIAL SUPPLY LIST:** THE DESIGN DRAWINGS WILL INCLUDE A COMPLETE MATERIALS SUPPLY LIST, PROVIDING MATERIAL SPECIFICATIONS FOR ALL COMPONENTS. SOME CONTINGENCY IN MATERIAL QUANTITY SHOULD BE INCLUDED TO ACCOUNT FOR POTENTIAL CHANGES IN THE SUBSURFACE CONDITIONS AT THE SITE. THIS WILL HELP TO REDUCE THE POTENTIAL FOR CONSTRUCTION DELAYS AND INCREASED COSTS DUE TO MATERIAL SHORTAGES.

CONCEPT DRAWINGS ONLY - NOT FOR CONSTRUCTION

ASSUME NOT TO SCALE

SCALE AS SHOWN

Designed CVB Date JULY2011
Checked CVB Date JULY2011
Drawn HM Date JULY2011

Rev	Date	DESCRIPTION	Init	
1	June 2015	Text Edits	HM	

REVISIONS

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Province of British Columbia
MINISTRY OF FOREST, LANDS AND NATURAL RESOURCE OPERATIONS
ENGINEERING BRANCH

STANDARD BRIDGE DRAWING

Terraspan® GRS Arch™ Structure–Conceptual Only

General Notes – Sheet 2

ORIGINAL SIGNED and SEALED BY: Calvin VanBuskirk, P.Eng., P.Geo.
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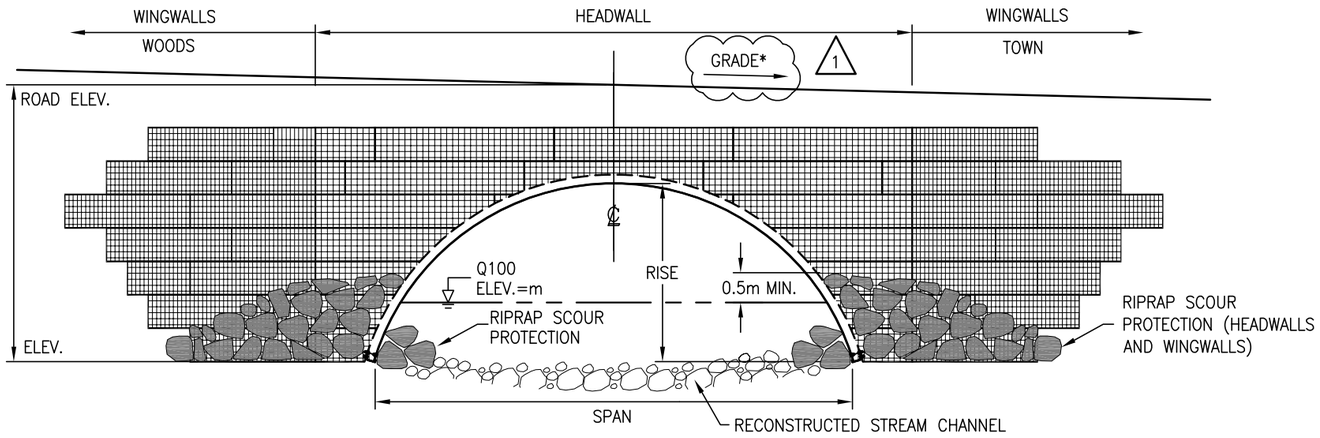
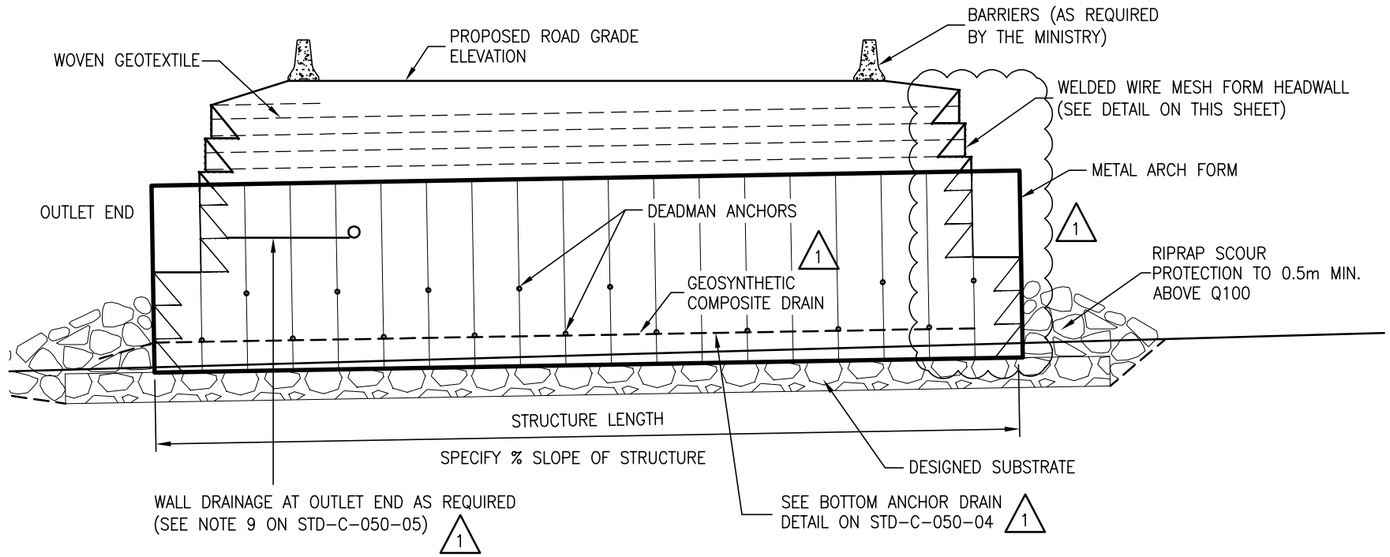
DESIGN ENGINEER Calvin VanBuskirk, P.Eng., P.Geo.
FLNR ENGINEER
DATE June 2015
DATE
FILE No.
DRAWING No. STD–C–050–02 1

CANCEL PRINTS BEARING PREVIOUS NUMBER



GRS ARCH™ UPSTREAM ELEVATION (FOR RETAINED HEADWALLS AND WINGWALLS)

1:100

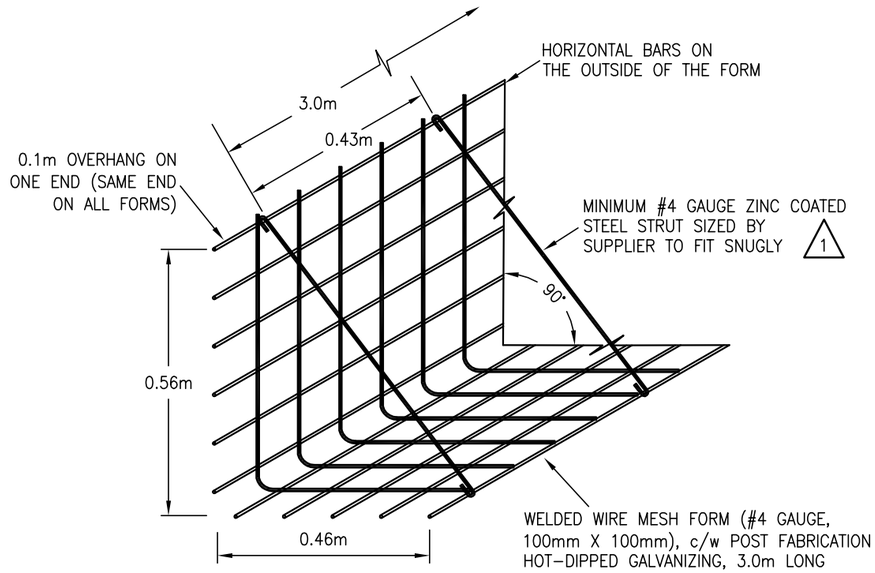


GRS ARCH™ PROFILE (FOR RETAINED HEADWALLS AND WINGWALLS)

1:100

*NOTE:
CONSTRUCTED ROAD PROFILE TO CONSIST OF A SUSTAINED GRADE (>1%) OR CREST OF VERTICAL CURVE. DO NOT LOCATE IN BOTTOM OF SAG CURVE.
SEE NOTE 3.8 ON STD-C-050-01

1



TYPICAL WELDED WIRE MESH FORM DETAIL (N.T.S.)

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CANADA AND US PATENT

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Designed CVB Date JULY2011
Checked CVB Date JULY2011
Drawn HM Date JULY2011

Rev	Date	DESCRIPTION	Init	
1	June 2015	Miscellaneous Updates	HM	

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Terraspan® GRS Arch™ Structure–Conceptual Only
Example Profile and Elevation for Permanent
Reconstructed Stream Channel Type Installation

ORIGINAL SIGNED and SEALED BY: Calvin VanBuskirk, P.Eng., P.Geo.
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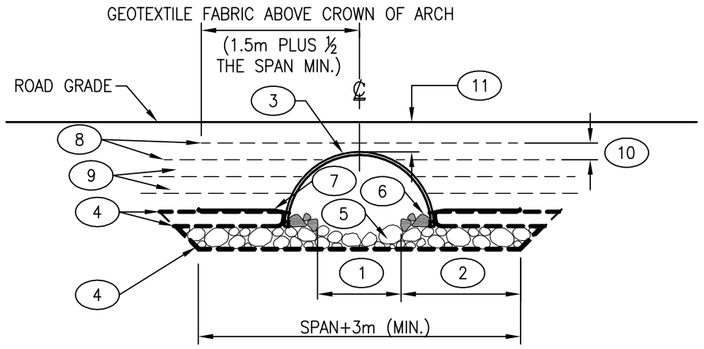
DESIGN ENGINEER Calvin VanBuskirk, P.Eng., P.Geo.
FLNR ENGINEER
DATE June 2015
DATE
FILE No.
DRAWING No. STD-C-050-03 1

CANCEL PRINTS BEARING PREVIOUS NUMBER

RECONSTRUCTED STREAM CHANNEL INSTALLATIONS (TO REPLACE EXISTING CULVERT)



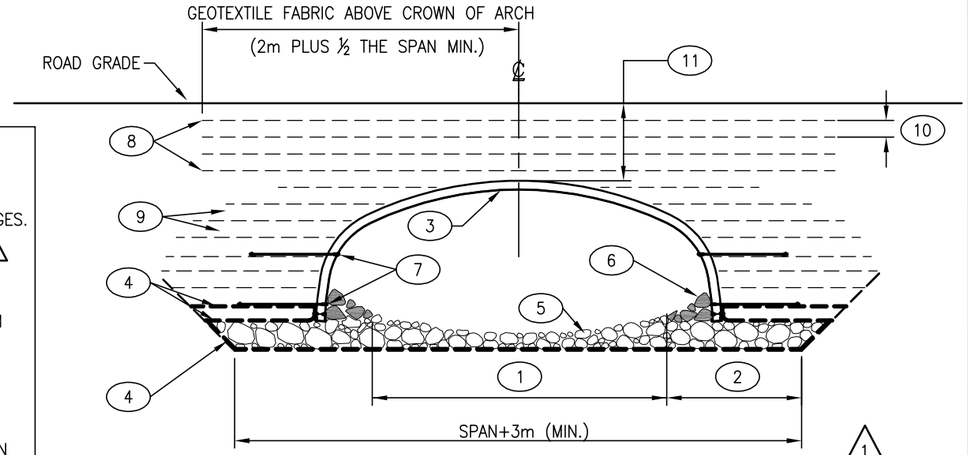
CSP ARCH FORM – MAX. 3.0m SPAN

CORRUGATION PROFILE 125mmx25mm, 2.8mm WALL THICKNESS. SEAMS WELDED FOR 75mm FROM BOTH CUT EDGES AND FOR 150mm AT THE TOP OF THE ARCH. TREAT (PAINT) WELDED AREA WITH COLD ZINC.

STREAM CHANNELS TYP. <1.5m WIDE
DESIGN DISCHARGE TYP. <3.0m³/sec
DESIGN WATER DEPTH TYP.<0.75m

LEGEND

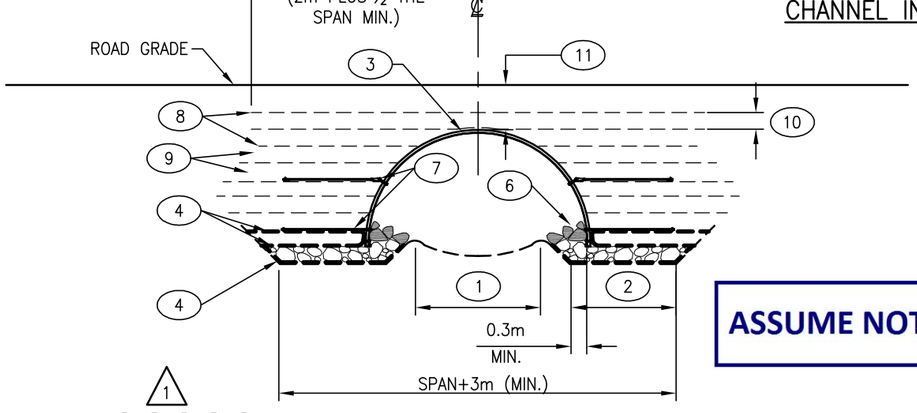
1. –RECONSTRUCTED OR UNDISTURBED STREAM CHANNEL WIDTH
2. –PREPARED FOUNDATION, TYPICALLY ROCKFILL (MIN. 1.5m WIDTH)
3. –METAL ARCH FORM WITH CHANNEL OR ANGLE ALONG BOTTOM EDGES. SPAN TO BE A MINIMUM OF 20% MORE THAN THE NATURAL, REPRESENTATIVE STREAM CHANNEL WIDTH AS DETERMINED BY A SITE ASSESSMENT (1)
4. –NON–WOVEN GEOTEXTILE AS REQUIRED 890N MIN. GRAB TENSILE STRENGTH (ASTM D4632), 580N MIN. PUNCTURE STRENGTH (ASTM D4833)
5. –DESIGNED SUBSTRATE
6. –RIPRAP SCOUR PROTECTION (INTERIOR OF METAL ARCH FORM)
7. –DEADMAN ANCHORS
8. –WOVEN GEOTEXTILE FABRIC 30kN/m (MIN.) WIDEWIDTH TENSILE STRENGTH (ASTM D4595), LENGTH OF FABRIC 2.2m MIN. BETWEEN BOTTOM OF FIRST ROW OF ANCHORS AND CROWN OF ARCH FORM
9. –COMPACTED GRANULAR FILL
10. –TYPICAL FABRIC SPACING 0.28m
11. –MINIMUM GRS FILL COVER DEPTH IS 20% OF THE SPAN (NO LESS THAN 0.4m). MAXIMUM FILL DEPTH TO BE DETERMINED BY DESIGN ENGINEER CONSIDERING AXIAL COMPRESSION LOADING, FOUNDATION CONDITIONS AND METAL WALL THICKNESS. (1)



LOW PROFILE DEEP CORRUGATED PLATE ARCH FORM – 4.0m TO 6.6m SPAN

(1) MINIMUM 4.1mm WALL THICKNESS

STREAM CHANNELS TYP. <5.0m WIDE
DESIGN DISCHARGE TYP. <12.0m³/sec
DESIGN WATER DEPTH TYP.<1.0m

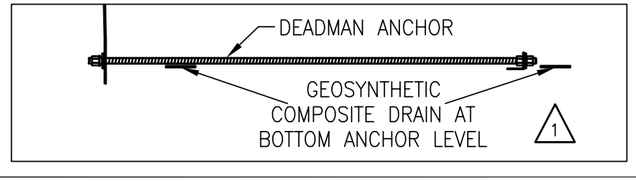


STRUCTURAL PLATE ARCH FORM – 3.0m TO 6.0m SPAN

3mm WALL THICKNESS, CORRUGATION PROFILE 152mmX51mm

STREAM CHANNELS TYP. <5m WIDE
DESIGN DISCHARGE TYP. <10m³/sec
DESIGN WATER DEPTH TYP.<0.75m

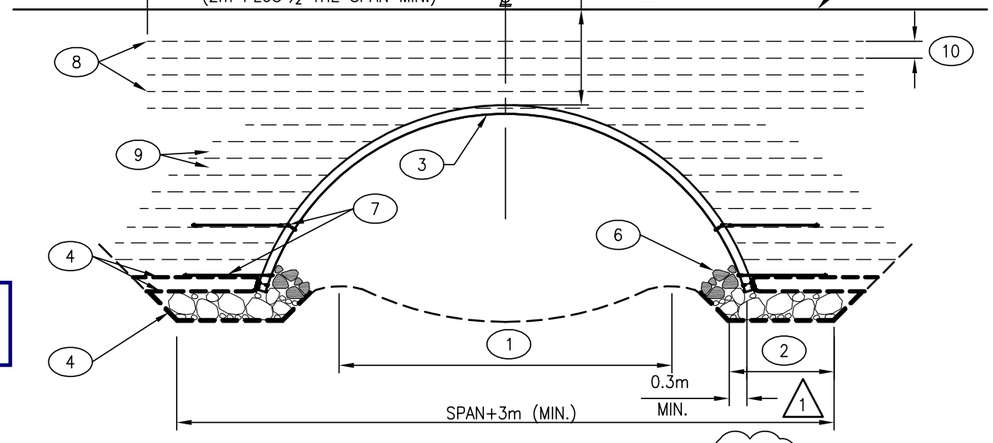
BOTTOM ANCHOR DRAIN DETAIL – SEE STD–C–050–03



CANADA AND US PATENT

NATURAL STREAM CHANNEL INSTALLATIONS

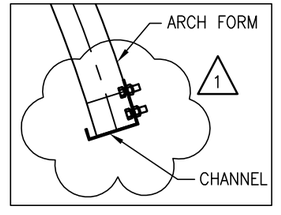
ASSUME NOT TO SCALE



SINGLE RADIUS DEEP CORRUGATED PLATE ARCH FORM – 8.3m OR LESS SPAN

(1) MINIMUM 4.1mm WALL THICKNESS

STREAM CHANNELS TYP. <6.0m WIDE
DESIGN DISCHARGE TYP. <16.0m³/sec
DESIGN WATER DEPTH TYP.<1.0m



CHANNEL DETAIL

CONCEPT DRAWINGS ONLY - NOT FOR CONSTRUCTION

SCALE AS SHOWN

Designed CVB Date JULY2011
Checked CVB Date JULY2011
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1	June 2015	Miscellaneous updates	HM

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ENGINEERING BRANCH

STANDARD BRIDGE DRAWING

Terraspan® GRS Arch™ Structure–Conceptual Only
Typical Cross–sections for Reconstructed and Natural Stream Channel Type Installations

ORIGINAL SIGNED and SEALED BY: Calvin VanBuskirk, P.Eng., P.Geo.
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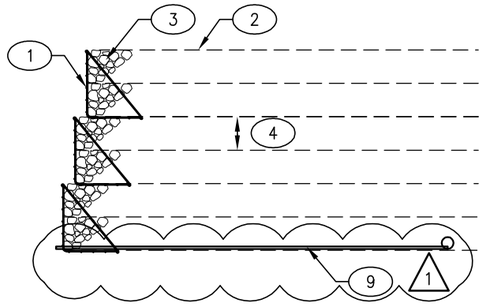
DESIGN ENGINEER Calvin VanBuskirk, P.Eng., P.Geo.
FLNR ENGINEER
DATE June 2015
DATE
FILE No.
DRAWING No. STD–C–050–04 | 1

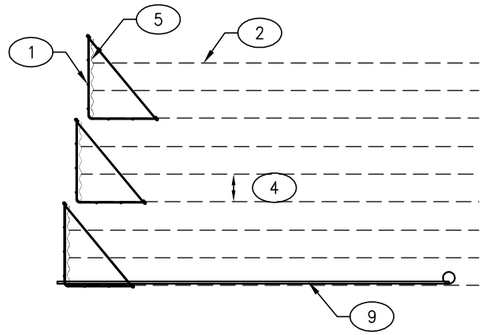
CANCEL PRINTS BEARING PREVIOUS NUMBER

RETAINED HEADWALLS AND WINGWALLS FOR INLET AND OUTLET ENDS

A. DURABLE MATERIALS AT THE FACE FOR PERMANENT TERM FSRs

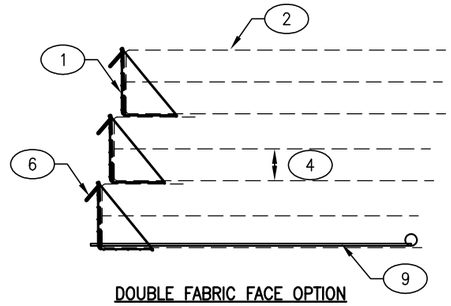


ROCK FILL FACE OPTION



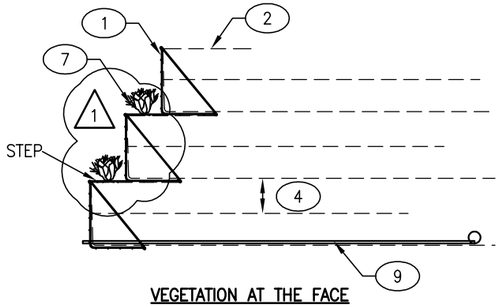
METAL FACE OPTION

B. DOUBLE LAYERED GEOTEXTILE FABRIC AT THE FACE FOR TEMPORARY TERM FSRs

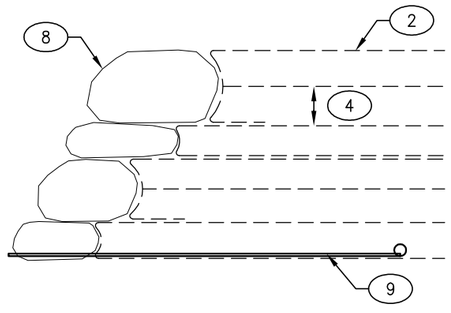


DOUBLE FABRIC FACE OPTION

REINFORCED SOIL SLOPES FOR INLET AND OUTLET ENDS



VEGETATION AT THE FACE
(SLOPES < 2V:1H)



STACKED ROCK AT THE FACE
(SLOPES < 2V:1H AND EMBANKMENT HEIGHT OF LESS THAN 4.0m)

ASSUME NOT TO SCALE

CONCEPT DRAWINGS ONLY - NOT FOR CONSTRUCTION

LEGEND

1
1. –WELDED WIRE MESH FORM, SET BACK DISTANCE TO SUIT SITE REQUIREMENTS, NEGATIVE SET BACKS NOT PERMITTED
2. –WOVEN GEOTEXTILE FABRIC 30kN/m (MIN.) WIDEWIDTH TENSILE STRENGTH (ASTM D4595)
3. –BROKEN ROCK OR COBBLE FILL
4. –TYPICAL FABRIC SPACING LESS THAN 0.3m
5. –GALVANIZED CORRUGATED METAL SHEETING MANUFACTURED IN ACCORDANCE WITH CAN/CSA–G401–07
6. –NON–WOVEN GEOTEXTILE 890N MIN. GRAB TENSILE STRENGTH (ASTM D4632), 580N MIN. PUNCTURE STRENGTH (ASTM D4833) IN FRONT OF WOVEN GEOTEXTILE
7. –SPECIFIED VEGETATION PLANTED ON BENCH, TYPICALLY 0.28m WIDE, TYPICALLY CONSISTING OF GRASSES, LEGUMES AND WOODY SPECIES AS NOTED ON DESIGN DRAWINGS. MONITOR VEGETATION TO CONFIRM IT IS ESTABLISHED IN GENERAL CONFORMANCE WITH THE DESIGN 1
8. –STACKED DURABLE ROCK – BOULDERS OR BROKEN ROCK (RIPRAP)
9. –WALL DRAINAGE AS REQUIRED CONSISTING OF PERFORATED PIPE(S) AND/OR GEOSYNTHETIC COMPOSITE DRAIN(S) TYPICAL FOR ALL SECTIONS, OUTLET ONLY 1

SCALE AS SHOWN	Designed CVB Date JULY2011	Checked CVB Date JULY2011	Drawn HM Date JULY2011

Rev	Date	DESCRIPTION	Init
1	June 2015	Drainage detail added	HM

REVISIONS

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ENGINEERING BRANCH

STANDARD BRIDGE DRAWING

Terraspan® GRS Arch™ Structure–Conceptual Only

Inlet and Outlet Details

ORIGINAL SIGNED and SEALED BY: Calvin VanBuskirk, P.Eng., P.Geo.	APPROVED BY:
DESIGN ENGINEER Calvin VanBuskirk, P.Eng., P.Geo.	FLNR ENGINEER
DATE June 2015	DATE
FILE No.	DRAWING No. STD–C–050–05 |1

CANCEL PRINTS BEARING PREVIOUS NUMBER