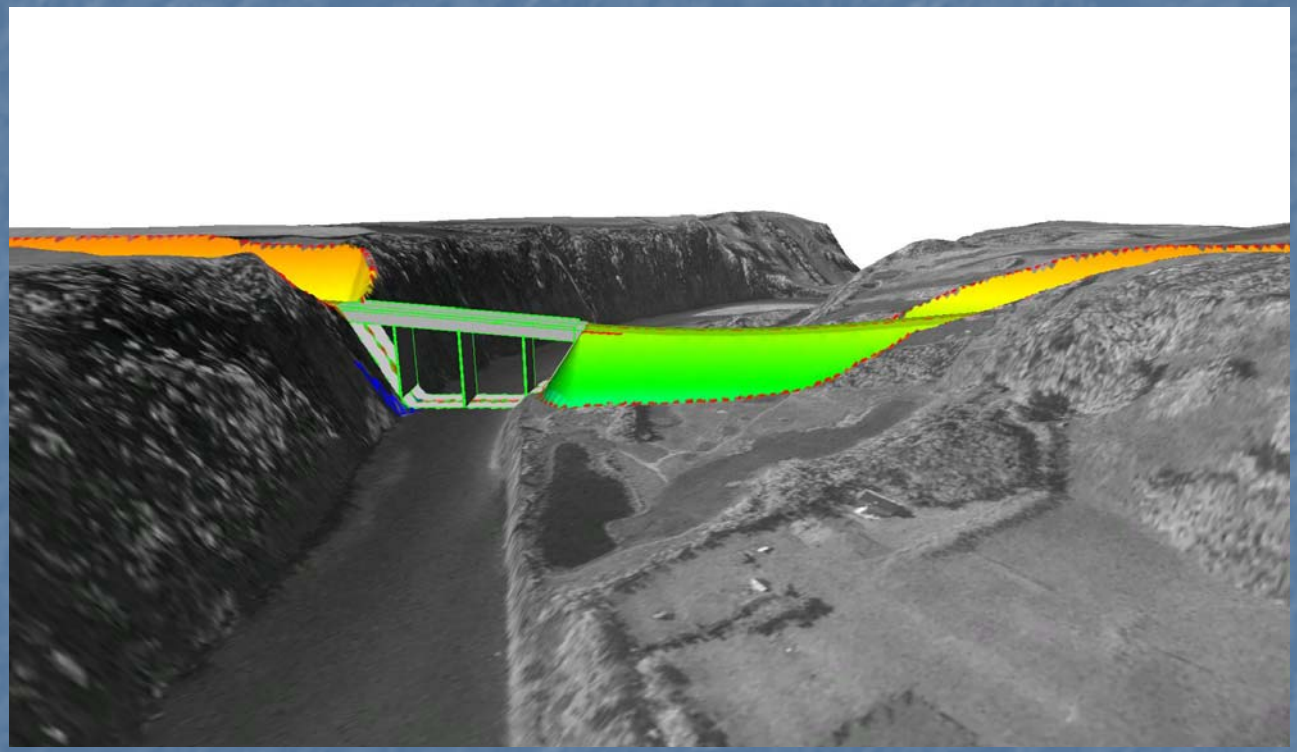
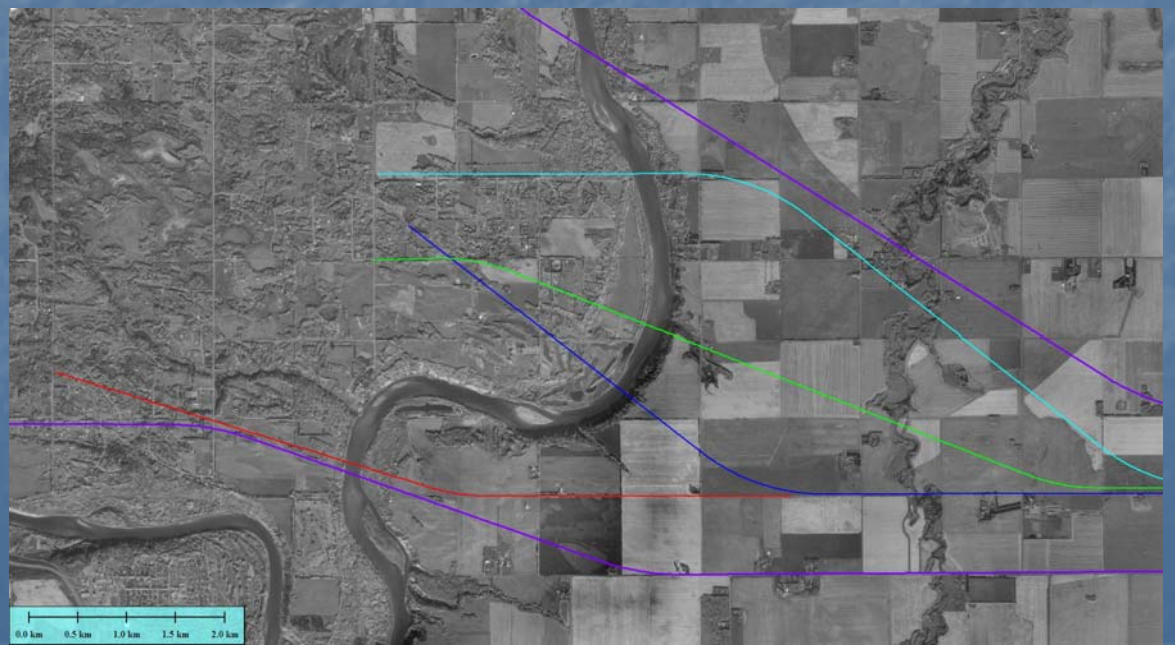
# Application of BPG Tool for Bridge Conceptual Planning



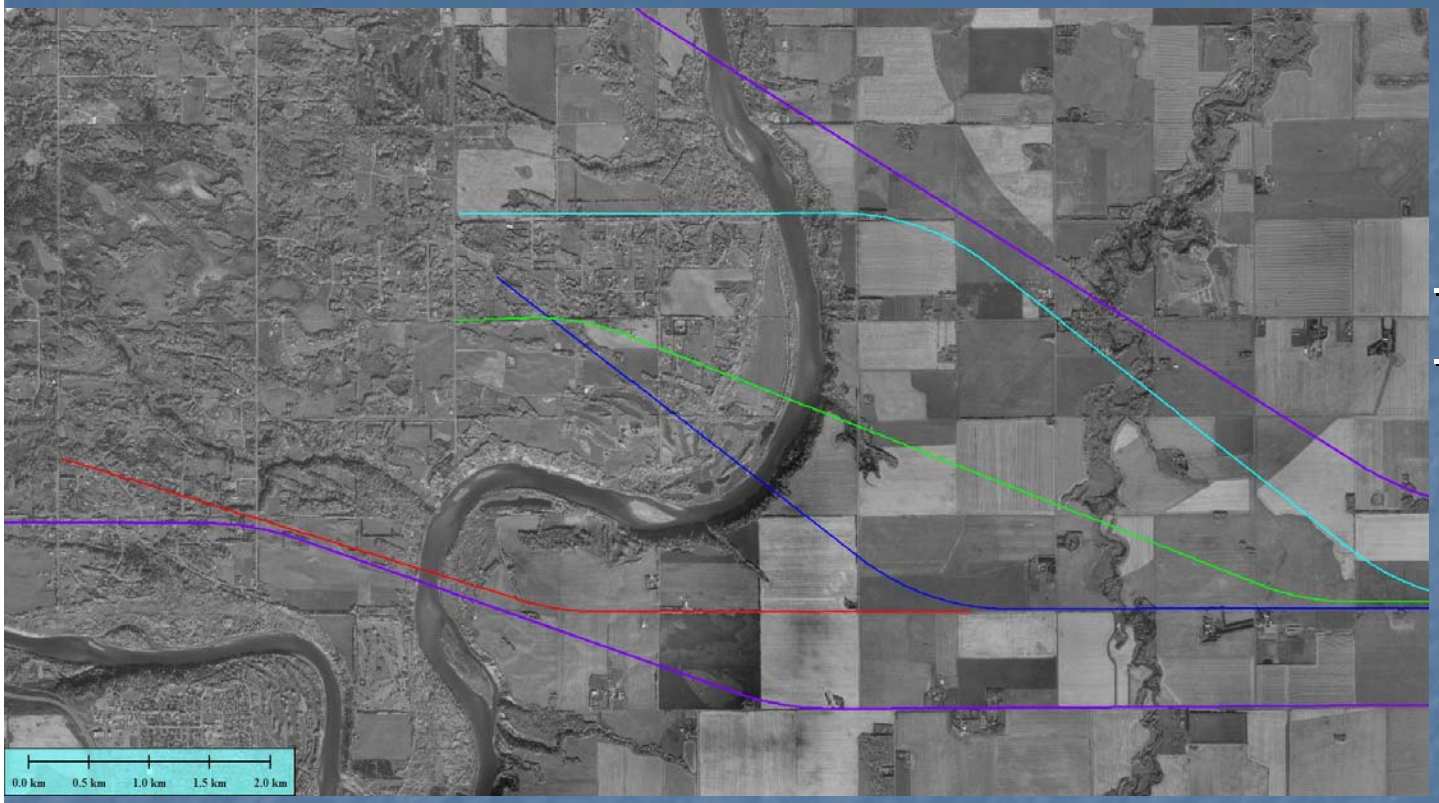
**Bridge Planning Workshop 2012**
**Alberta Transportation**

# What is BPG?

- **B**ridge **P**lanning **G**eometry tool
- Excel tool (with VBA code)
- Interacts with GIS viewing software (e.g. Global Mapper)
- Combines roadway and bridge layout geometry
- Quick ID/evaluation/visualization of bridge planning options



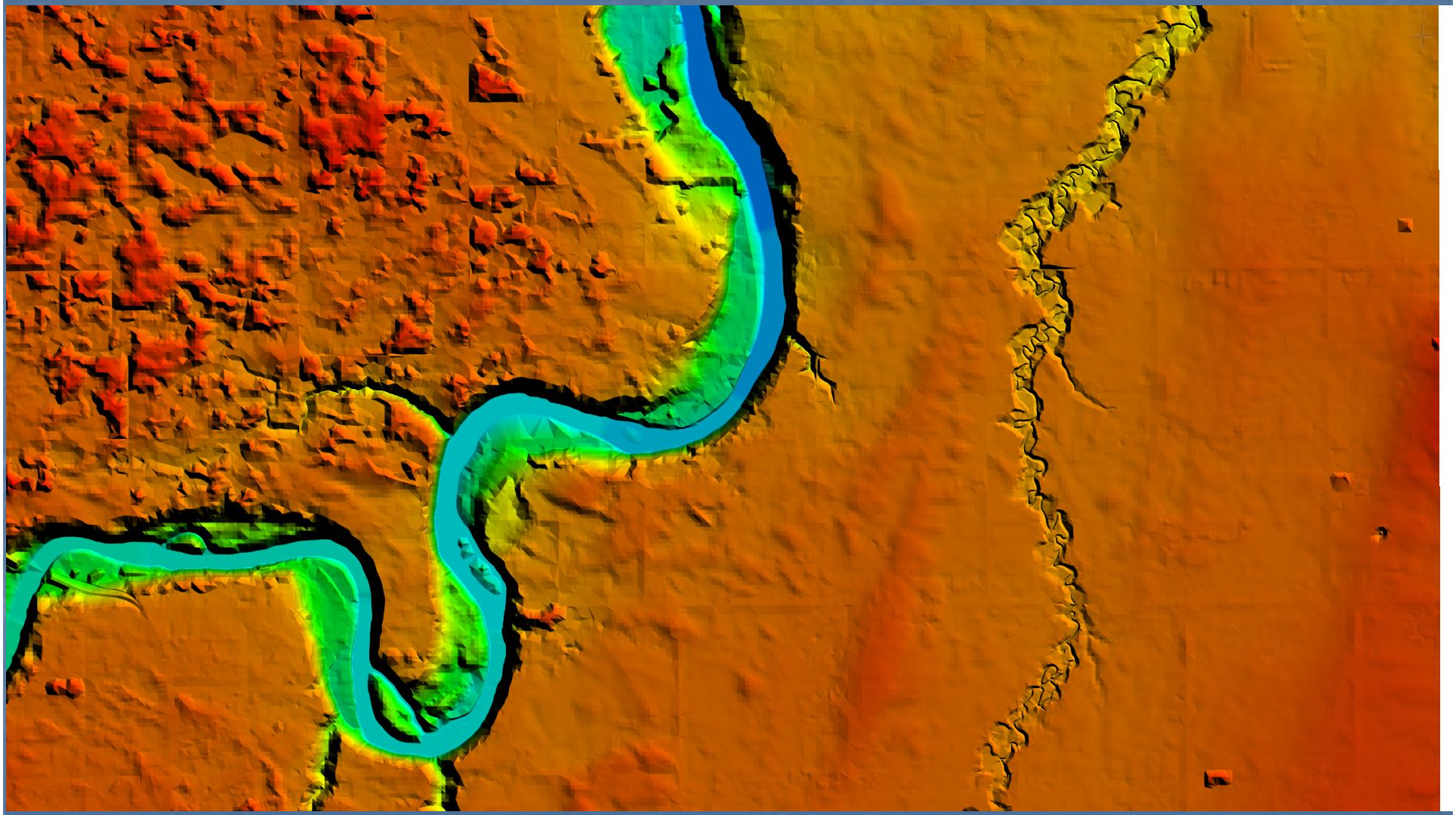
# What is BPG?




- Iterative process
- Assess many horiz/vert options

Considerations include
-road standards (design speed, k, G, R)
-potential/timing for future upgrades (AADT, land development)
-hydrotechnical design parameters (HW elev, V, deck drainage)
-RoW, utilities, environmental, geotechnical, lifecycle cost
-others..

# DEM File Visualization



- LiDAR, Survey, Photogrammetry, etc.

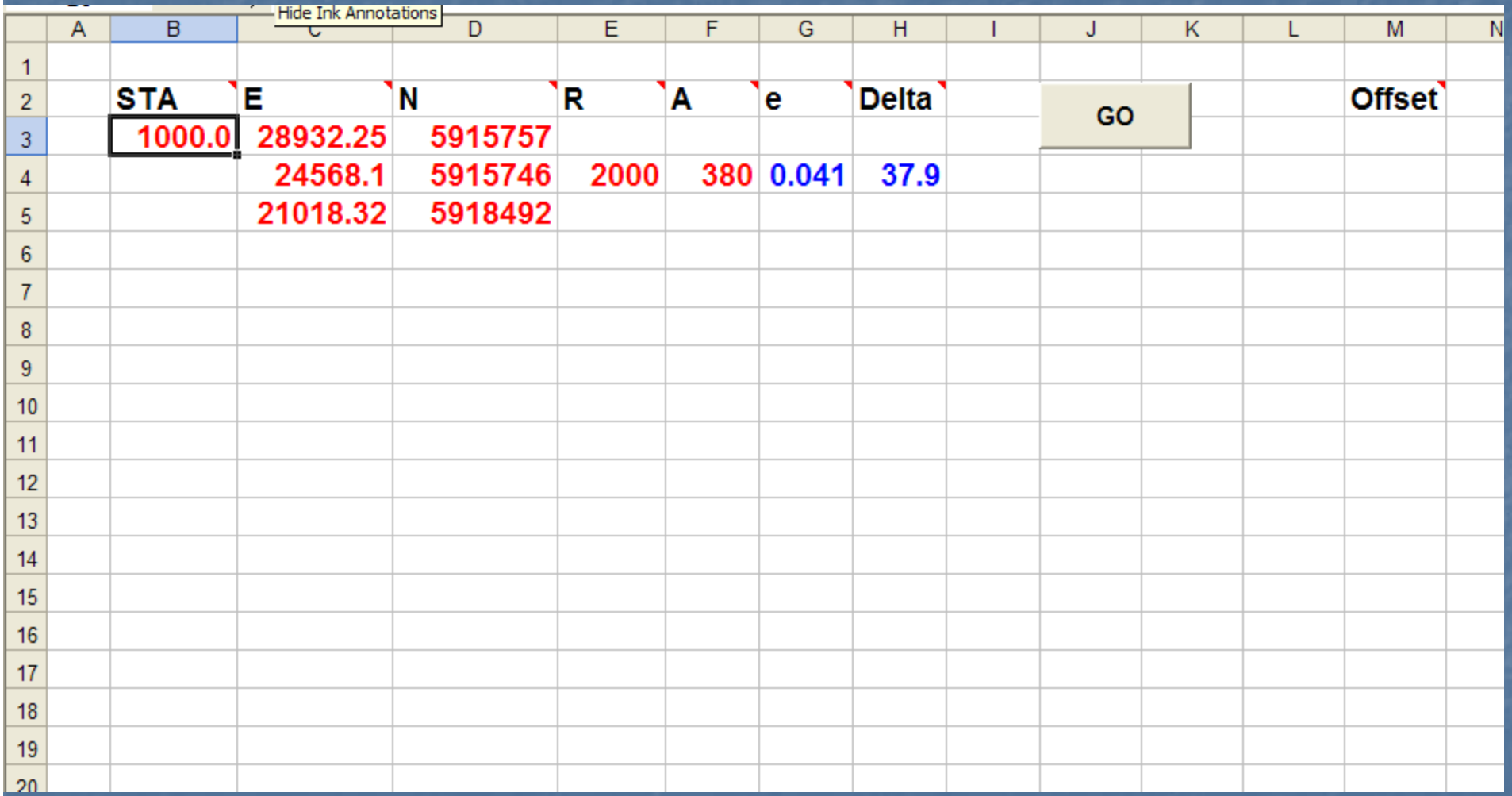
# Horizontal Alignment Factors

- Crossing Location
  - Width - cost
  - Skew – cost, structural complexity
  - Lateral Stability – cost, reliability, environmental impact
  - Slides – cost, maintenance
- Bridge Geometric Requirements
  - Tangent Preferable
  - Increased R – sight distance (rails), max gradient (icing)
  - Constant XS (icing) – no spirals

# Horizontal Alignment


- 1- impact to golf course, 2- river crossing, 3- stream crossing, 4- land severance, 5- minimize landowner impacts
- Initial road tangent working lines

# Horizontal Alignment - Input



| | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | |
| 2 | | STA | E | N | R | A | e | Delta | | GO | | | Offset | |
| 3 | | 1000.0 | 28932.25 | 5915757 | | | | | | | | | | |
| 4 | | | 24568.1 | 5915746 | 2000 | 380 | 0.041 | 37.9 | | | | | | |
| 5 | | | 21018.32 | 5918492 | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | |

- Red – input; Blue - output

# Horizontal Alignment - Plot


- CL, Stations, Curve data (ST, SC)

# Profile Factors

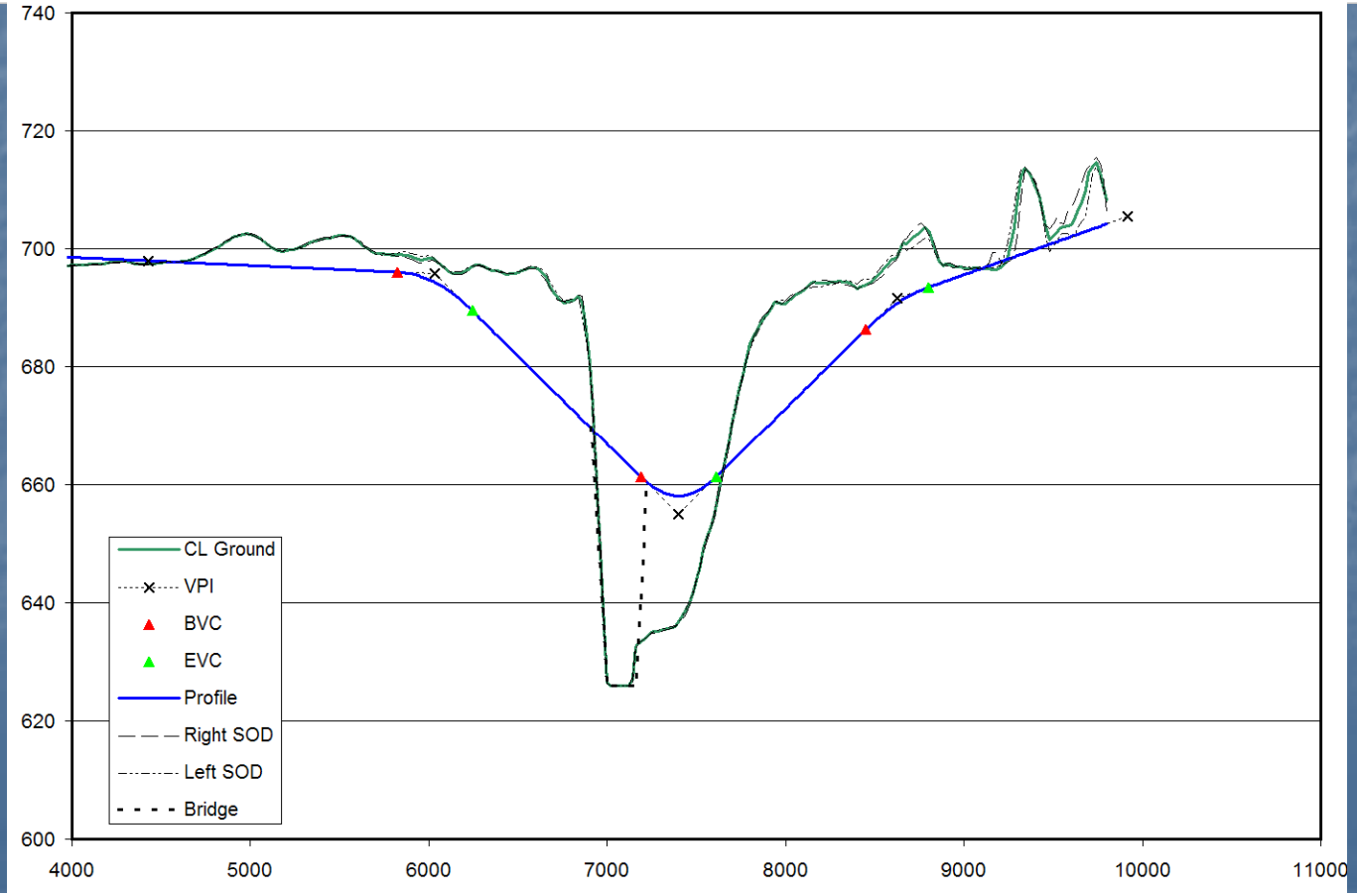
- Min Elevation (Hydraulic Control)
  - Min EL = HW EL + Freeboard + Structure Depth
  - HW EL based on AT HDG
  - Freeboard – BPG 12
  - Structure Depth – max span
- Deck Gradient Limits (AT BSDC)
  - Max 4% resultant (~ 3% longitudinal) – preferential icing
  - Min 1% - deck drainage (BPG 11)
- Valley Issues
  - Cut/Fill Balance
  - Max Hwy Grade – benefit/cost
  - Visual – Min. L(m) = 2X Design Speed (km/hr)

# Vertical Profile

| STA | EL | L | G | K | Type | Lmx | Warn |
|---|---|---|---|---|---|---|---|
| 4427 | 698.000 | | | | | | |
| 6035 | 695.800 | 420 | -0.14 | 146.9 | Crest | 2310 | OK |
| 7400 | 654.900 | 420 | -3.00 | 70.1 | Sag | 2100 | OK |
| 8625 | 691.600 | 350 | 3.00 | 182.4 | Crest | 2030 | OK |
| 9915 | 705.500 | | 1.08 | | | | |

GO

| Pt | Spot Elevations STA | EL | G |
|---|---|---|---|
| 1 | 7000.00 | 666.885 | -3.00 |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |

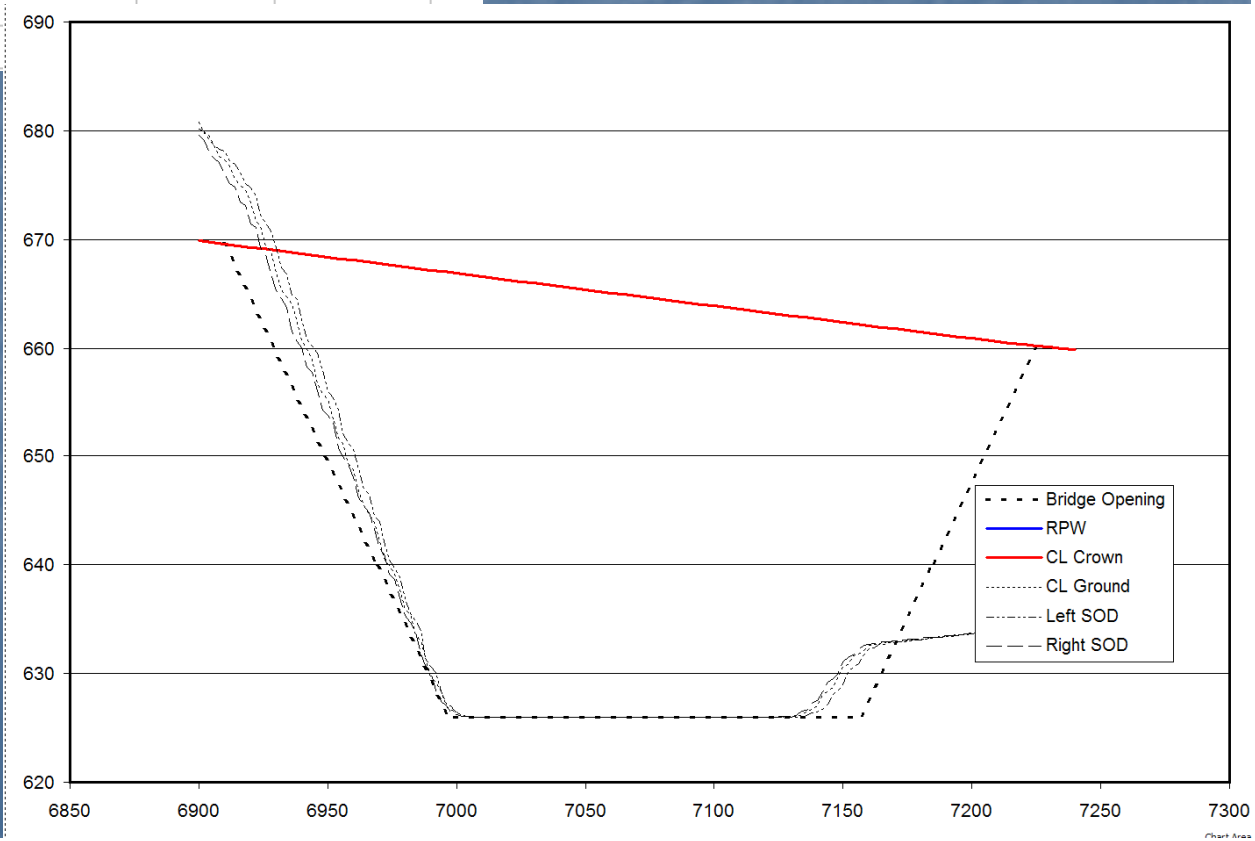


# Bridge Fills Factors

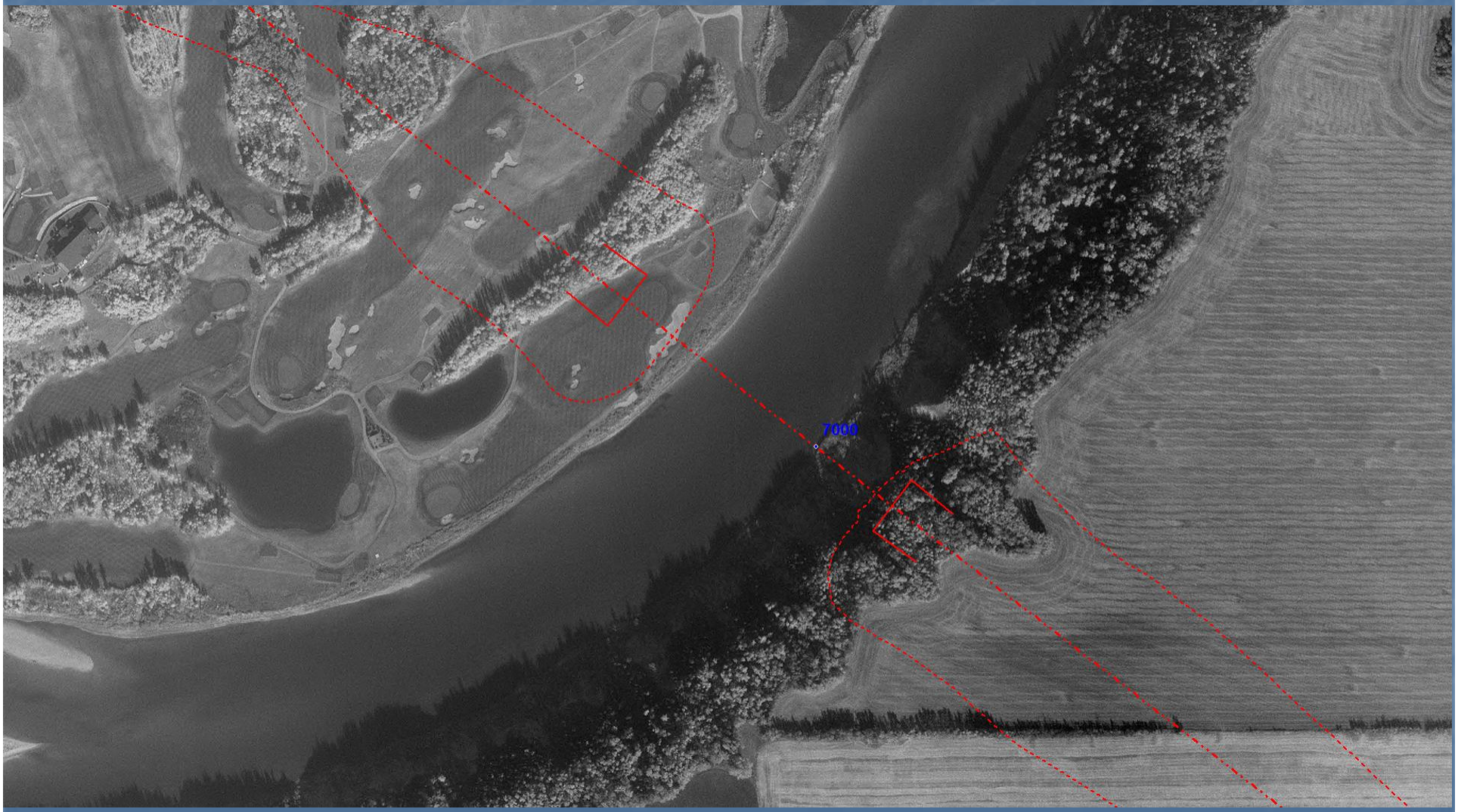
- Fill Location
  - Hydraulically Feasible – V, headloss, u/s flooding
  - Lateral tie-in to existing natural banks
  - Starting point – match existing natural banks
- Fill Configuration
  - Headslope ratio (typ 2:1, geotechnical, remediation)
  - Berms – geotechnical, access
  - Elliptical fill transition vs. guidebank

# Bridge Fills

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | | | EL | G | |
| 2 | Near Fill Station | 6910.000 | 669.582 | -2.996 | |
| 3 | Far Fill Station | 7225.000 | 660.231 | -2.497 | |
| 4 | Top of Fill Width | 60.0 | | | |
| 5 | Headslope Ratio | 2.0 | | | |
| 6 | Fill Sideslope Ratio | 3.0 | | | |
| 7 | Skew | 0.0 | | | |
| 8 | Bed EL (Theor.) | 627.000 | | | |
| 9 | Berm EL | 640.000 | | | |
| 10 | Headslope Berm Width | 0.0 | | | |
| 11 | GB Berm Width | 0.0 | | | |



# Bridge Fills - Plan

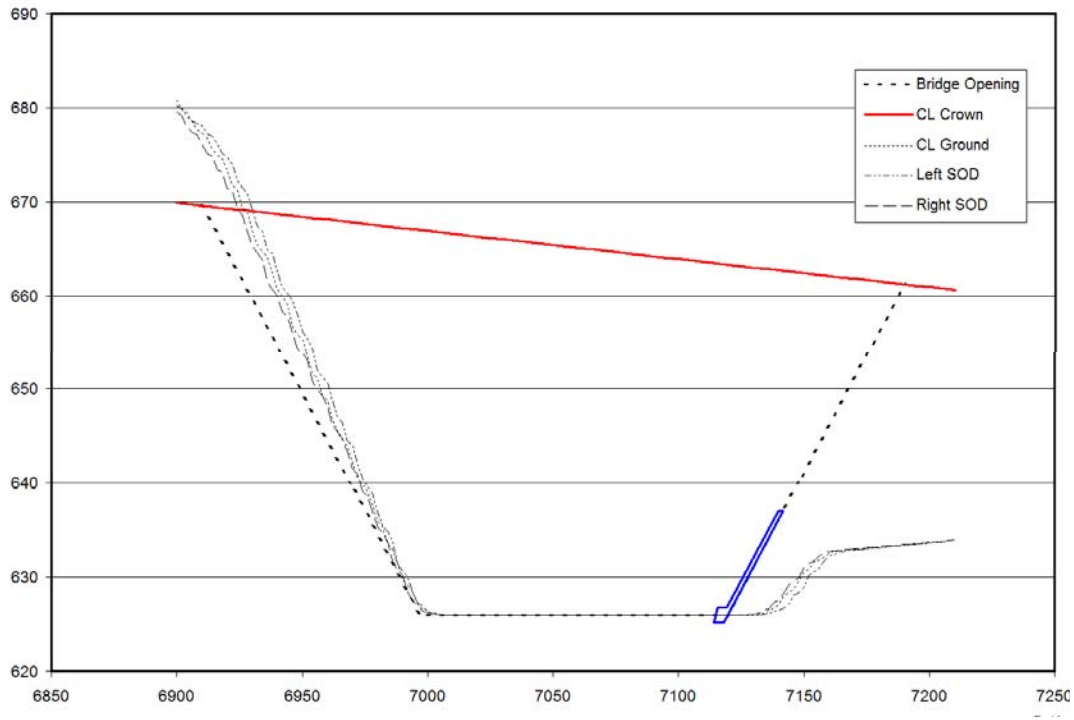


# Bridge Fills Protection Factors

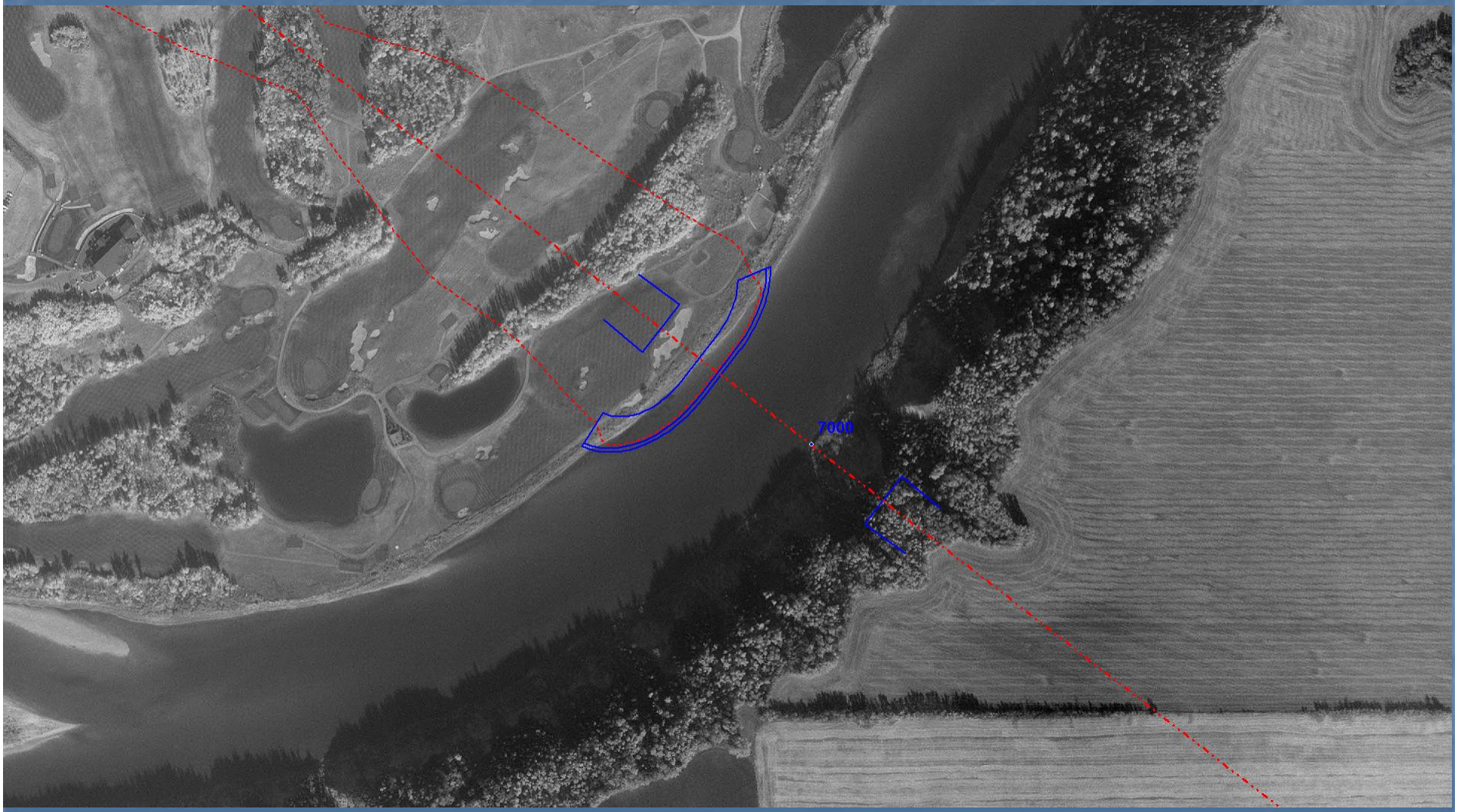
- Need
  - Fill in active channel
  - Lateral movement history
  - Signs of local bank instability
- Protection Details (BPG 9)
  - Rock (Class 1,2,3 – size distribution, BCS, Section 10)
  - Select based on V, lateral movement history
  - Launching Apron, rock to HW
- Extent
  - Configuration - headslope vs. guidebank
  - Tie apron into toe of banks
  - Smooth transition, target 2:1 (along stream vs. lateral)
- Additional River Engineering Features
  - Spurs – groups, spacing, projection
  - Channel realignment – align flow, reduce skew, maintain S

# Bridge Fills Protection

| | | | | | |
|---|---|---|---|---|---|
| 12 | Protection (H,G,N) | H | | | |
| 13 | Rock Thickness 't' (m) | 0.8 | | | |
| 14 | Top Of Rock EL | 637 | | | |
| 15 | Bottom Of Rock EL | 625.2 | | | |
| 16 | Apron Length | 4.0 | | | |
| 17 | | | | | |
| 18 | | Near Fill | | Far Fill | |
| 19 | | Left | Right | Left | Right |
| 20 | HS Rock Extent Angle | 50.0 | 50.0 | 85.0 | 60.0 |
| 21 | GB Radius | 20.0 | 20.0 | 80.0 | 80.0 |
| 22 | GB Extent Angle | 25.0 | 25.0 | 30.0 | 20.0 |
| 23 | GB Nose Wrap Angle | 30.0 | 30.0 | 30.0 | 30.0 |
| 24 | | | | | |
| 25 | | Square | Skew | | |
| 26 | Out to Out of Fill Length | 280.000 | 280.000 | | |
| 27 | Theoretical Bed Width | 122.451 | 122.451 | | |
| 28 | | | | | |
| 29 | Rock Vol. (Near) | 5675 | | | |
| 30 | Rock Vol. (Far) | 6981 | | | |
| 31 | Total Rock Volume | 12656 | | | |
| 32 | | | | | |



# Bridge Fills – Plan + RPW

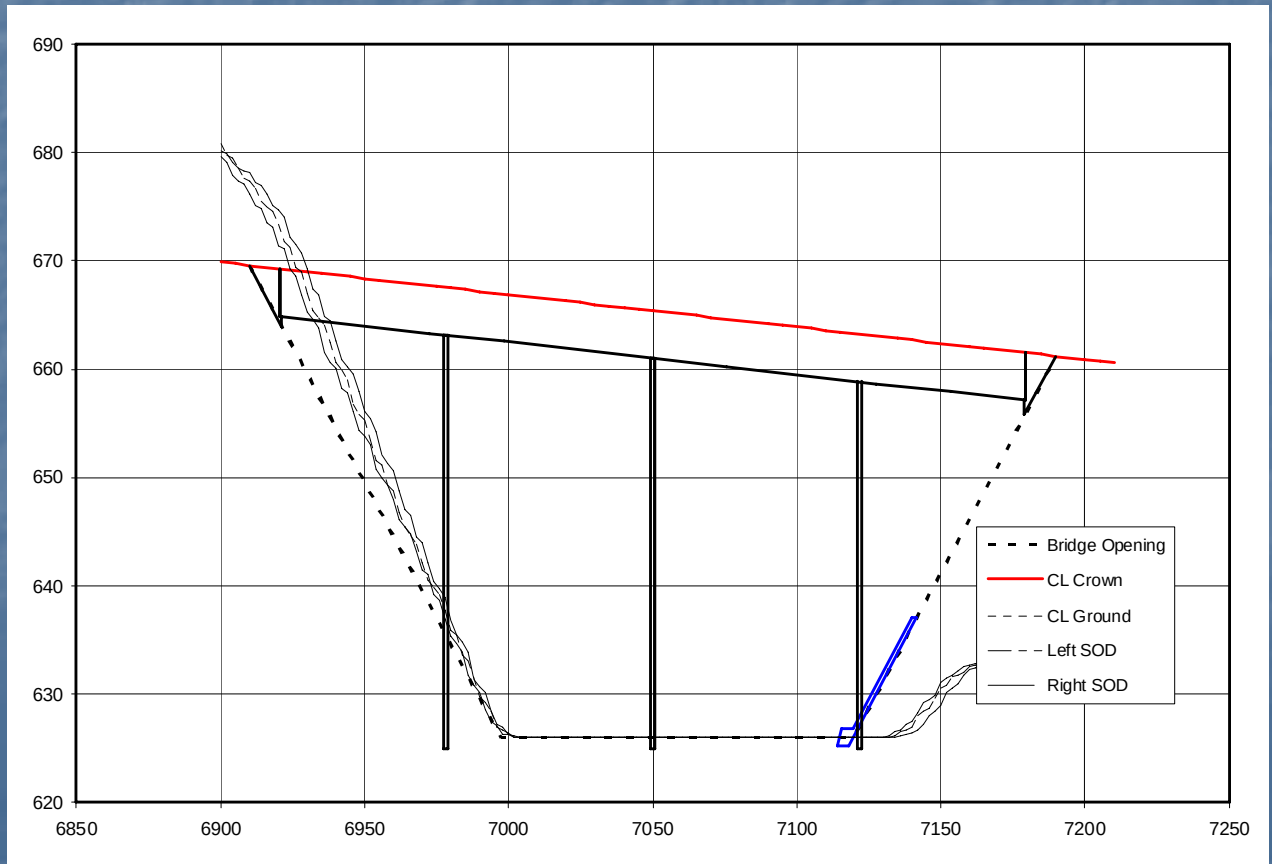


# Bridge Structure Geometry Factors

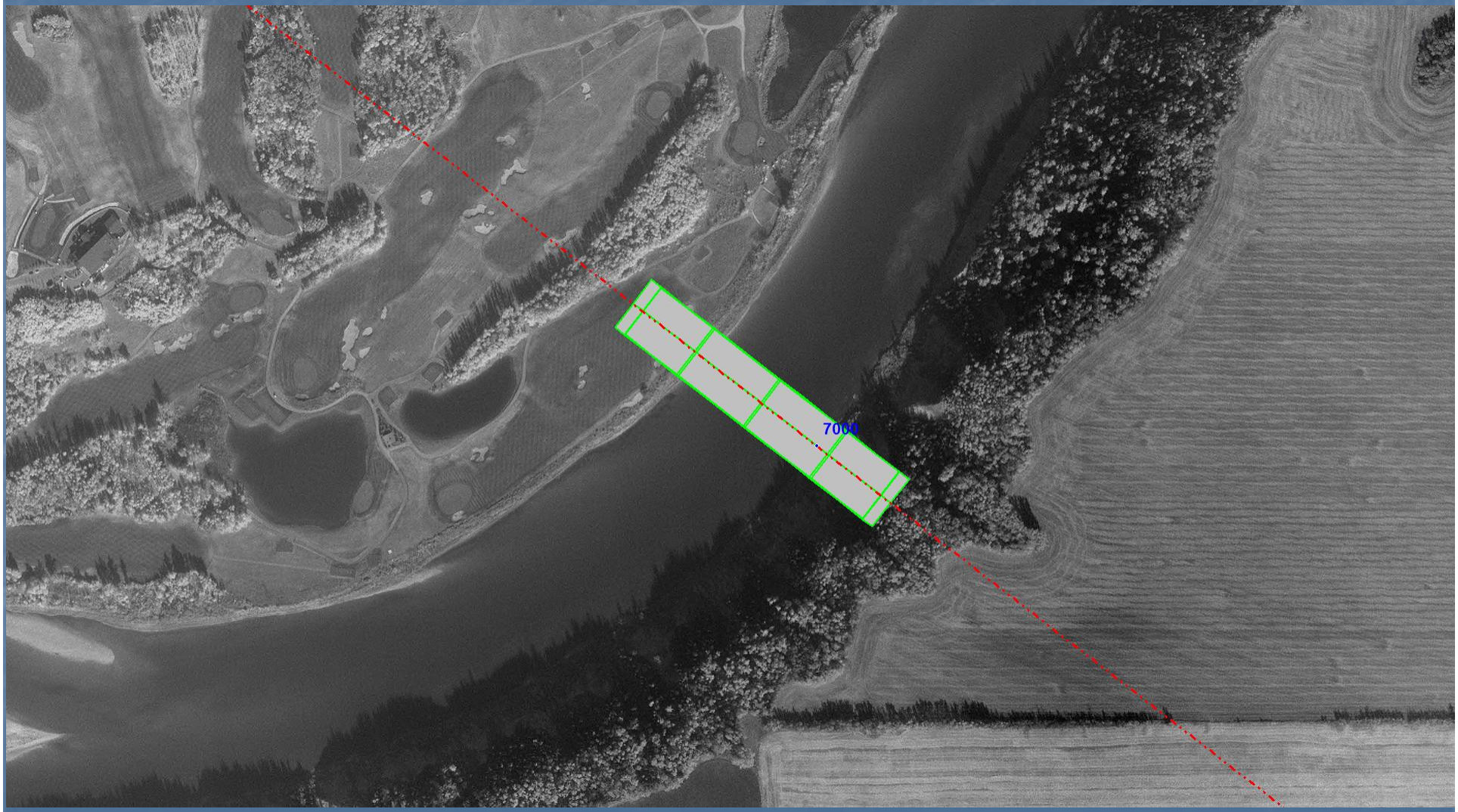
- Check grades, XS at bridge ends
- Visually check flow alignment, skew in 3D
- ID potential span options
  - Number of Spans, Piers
  - Span lengths – structure options
- Pier location issues
  - Drift, ice – blockage potential
  - Construction berm extents
  - Bank proximity – blockage, erosion

# Bridge Geometry

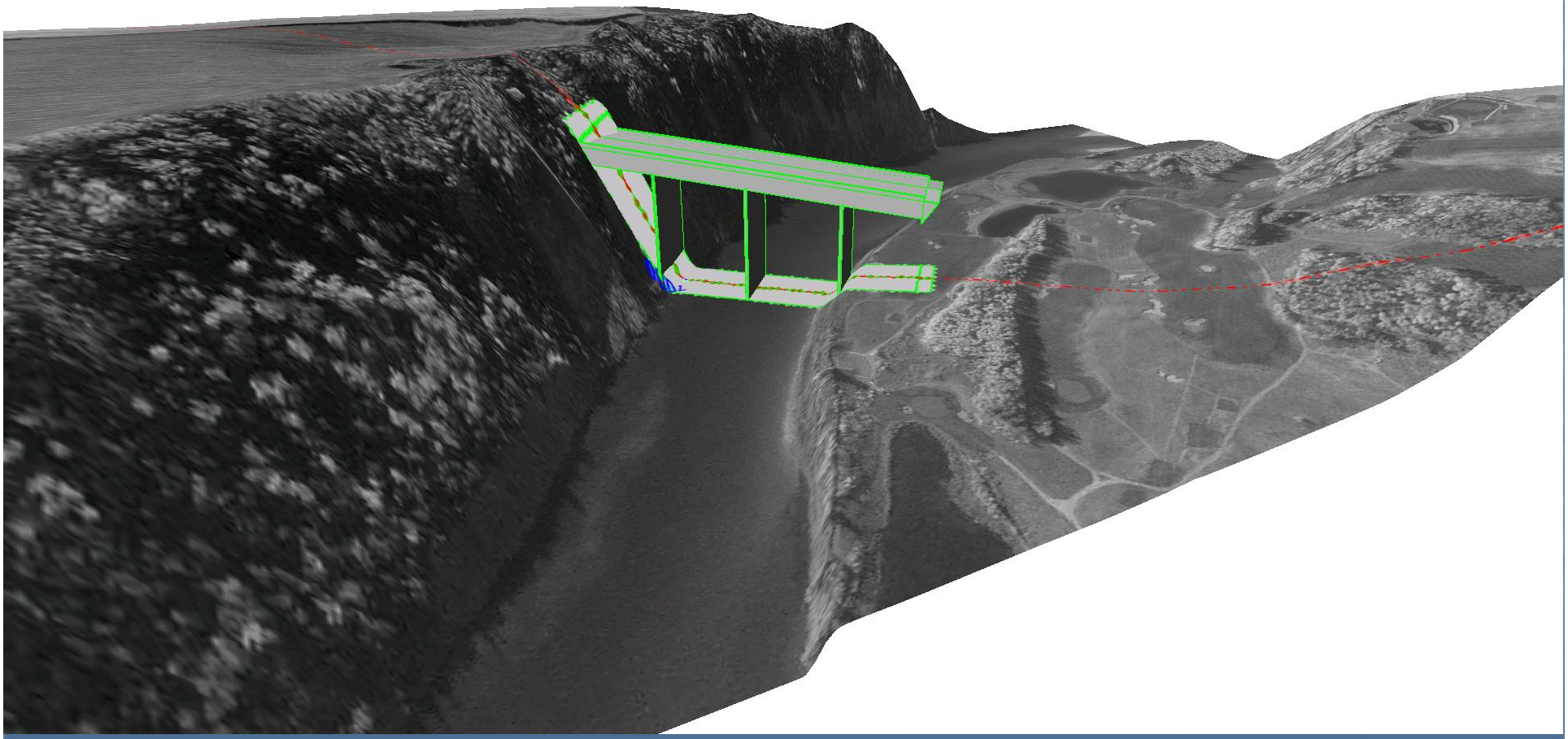
| 3D View Options | | Spans | Length (m) | | Calc Values | |
|---|---|---|---|---|---|---|
| Structure Depth (m) | | 1 | | 3D Bridge | Structure Depth (m) | 4.8 |
| Abutment Ht. (m) | | 2 | | | Abutment Ht. (m) | 1.0 |
| Pier Width (m) | | 3 | | | Pier Width (m) | 2.0 |
| Calc. Bridge Length (m) | 291.6 | 4 | | | Span 1 | 64.8 |
| Check Abutment Height (m) | 1.0 | 5 | | | Span 2 | 81.0 |
| | | | | | Span 3 | 81.0 |
| | | | | | Span 4 | 64.8 |



# Bridge Geometry - Plan



# Bridge Geometry – 3D



# Grading Volume Factors

- Grading Volume Costs
  - Alignment
  - Profile
  - Bridge Length
  - XS
- Feasibility
  - Depth of cut, Height of fill – geotechnical stability
  - Lateral Extent of impact – land, river, wetland, development
- Issues
  - Balance cut and fill
  - Borrow Source / Waste areas

# Grading Volume - Input

| | |
|---|---|
| **Cross Section Parameters** | |
| Design Road Width (m) | 60 |
| Road Sideslope Ratio (H:V) | 3 |
| Backslope Ratio (H:V) | 3 |
| Ditch Depth (m) | 1.5 |
| Ditch Width (m) | 4 |
| Sideslope Transition Location (m) | 100 |
| Sideslope Transition Length (m) | 20 |
| | |
| **XS Data and Plot** | |
| STA | 6700.000 |
| | |
| Left Limit | -106.4 |
| Right Limit | 94.3 |
| Area - Fill | 0.0 |
| Area - Cut | 2557.0 |
| | |
| **Road Grading Volume** | |
| STA 1 | 4600.000 |
| STA 2 | 9200.000 |
| | |
| Vol. Fill | 849455 |
| Vol. Cut | 4135113 |

Go XS

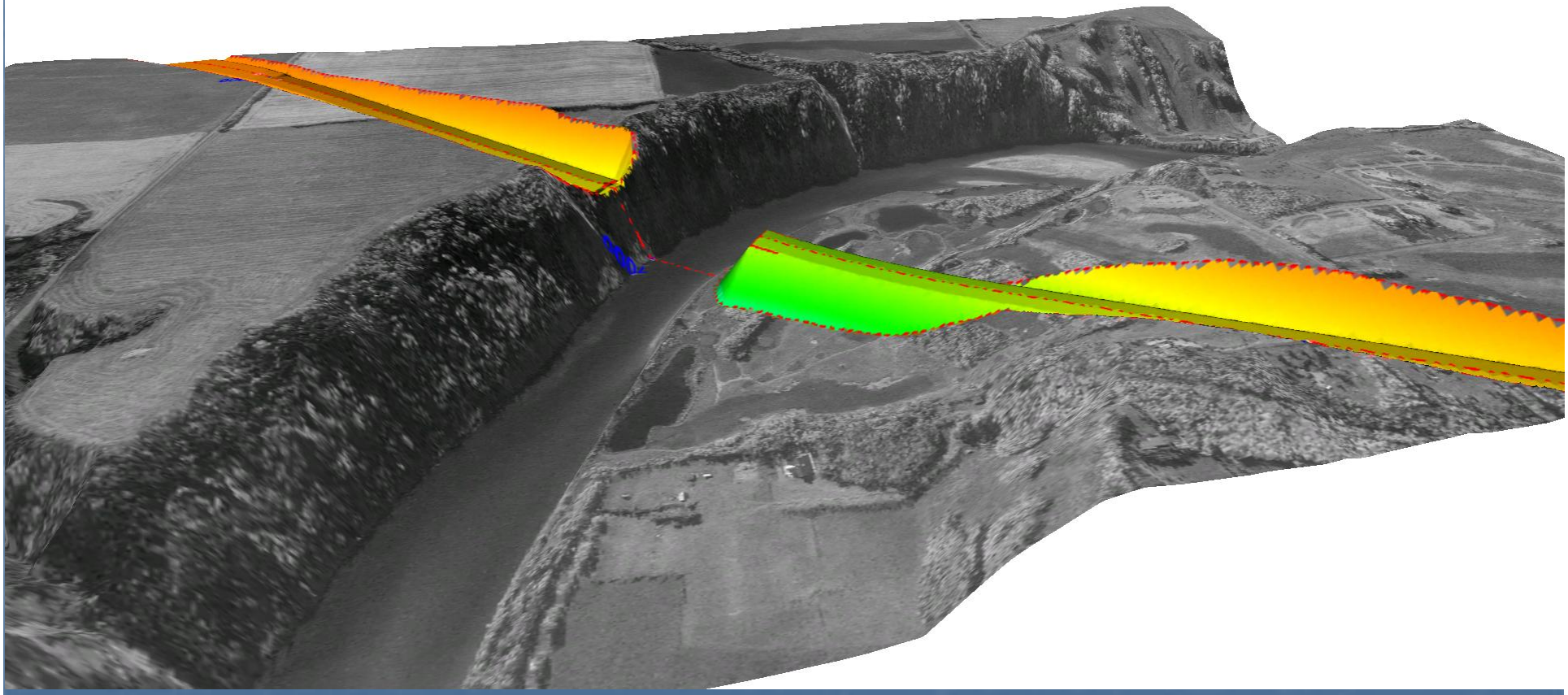
Go Vol

Make Grading Limits File

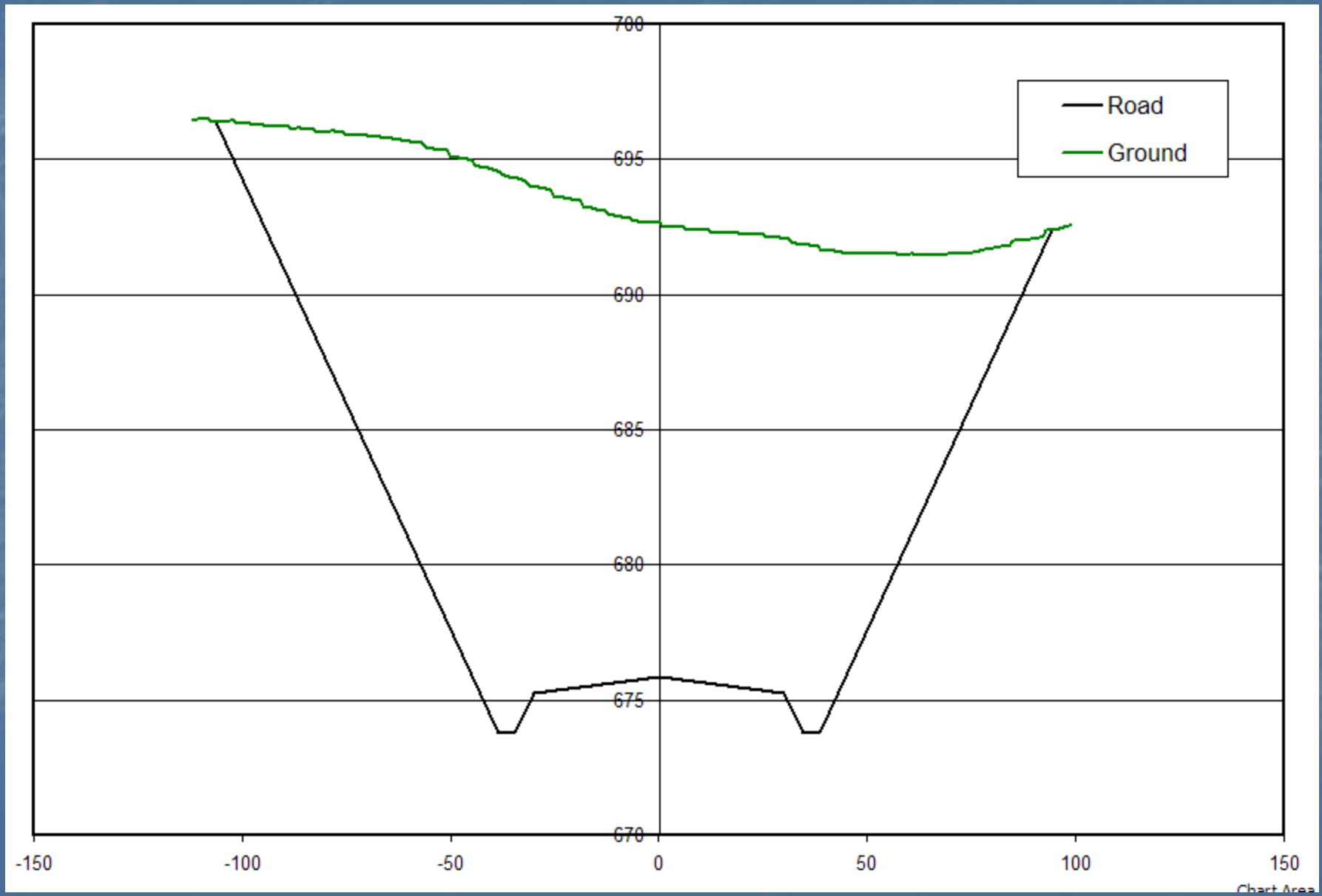
Make 3D Road Vector File

Make 3D Road Pts File

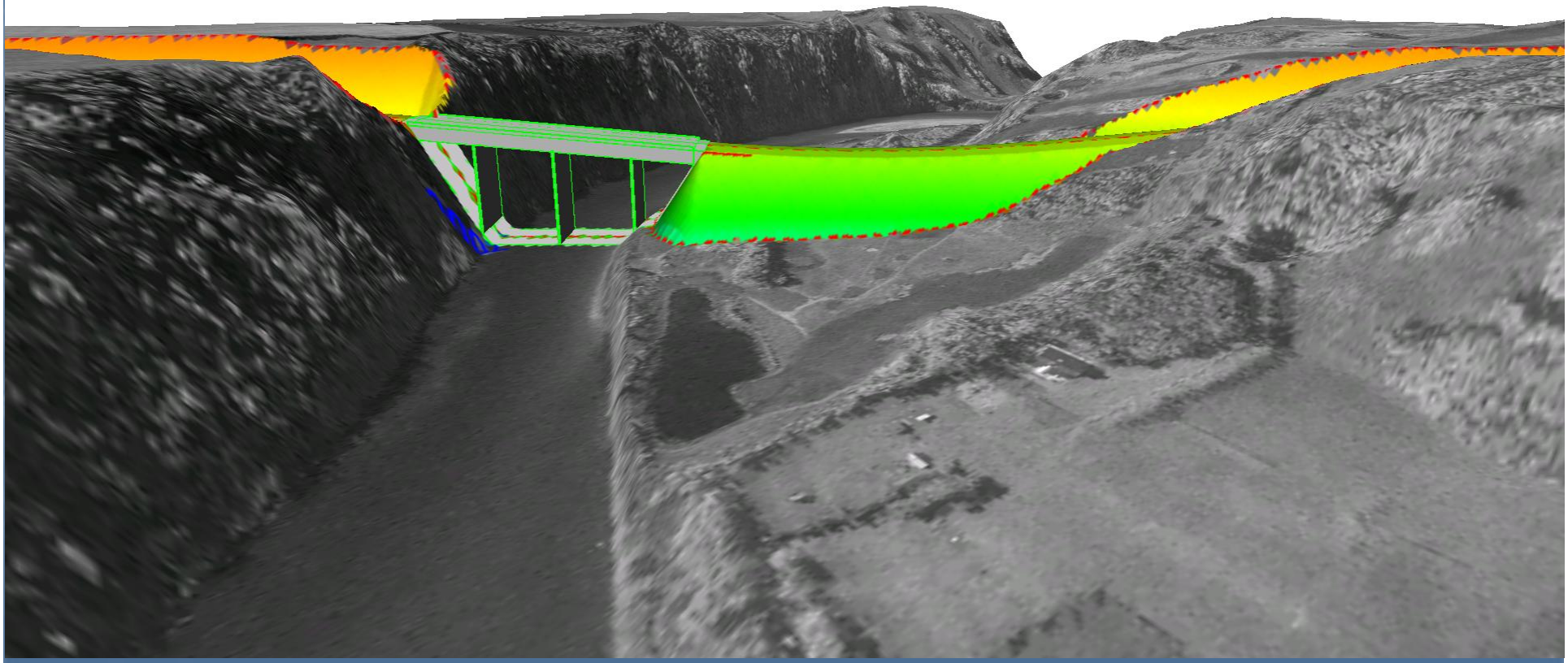
# 3D Grading View



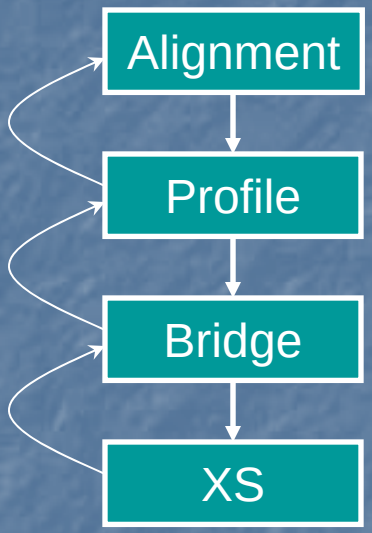
# XS Plot


700
695
690
685
680
675
670
-150
-100
-50
0
50
100
150
Road
Ground
Chart Area

# 3D Grading View –with Bridge



# Work Flow




- Many Combinations of Alignment, Profile, and Bridge
- Iterative Process To Develop a Feasible Option
- Many Steps to Develop Optimized Option for Alignment

# Alternative Comparison

- Pros/Cons of each option
- Grading volumes/roadway standards
- Bridge length/height
- Land/RoW/enviro/utilities/etc.
- Costs

# QUESTIONS?