Seven County Infrastructure Coalition - Uinta Basin Railway:
Evaluation of Potential Route Alternatives

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The Seven County Infrastructure Coalition ("Coalition") proposes to construct a new rail line connecting potential areas of shipper and receiver terminals located at South Myton Bench and Leland Bench, Utah to the national railway network. The Coalition engaged HDR Engineering, Inc. ("HDR") to identify potential route options for such a rail line and to provide an evaluation of these alternatives. A summary of that process is provided below.

I. Route Objectives

To guide its evaluation of potential alternatives, the Coalition and HDR identified certain objectives that a railway route would have to meet to be considered feasible. These objectives include:

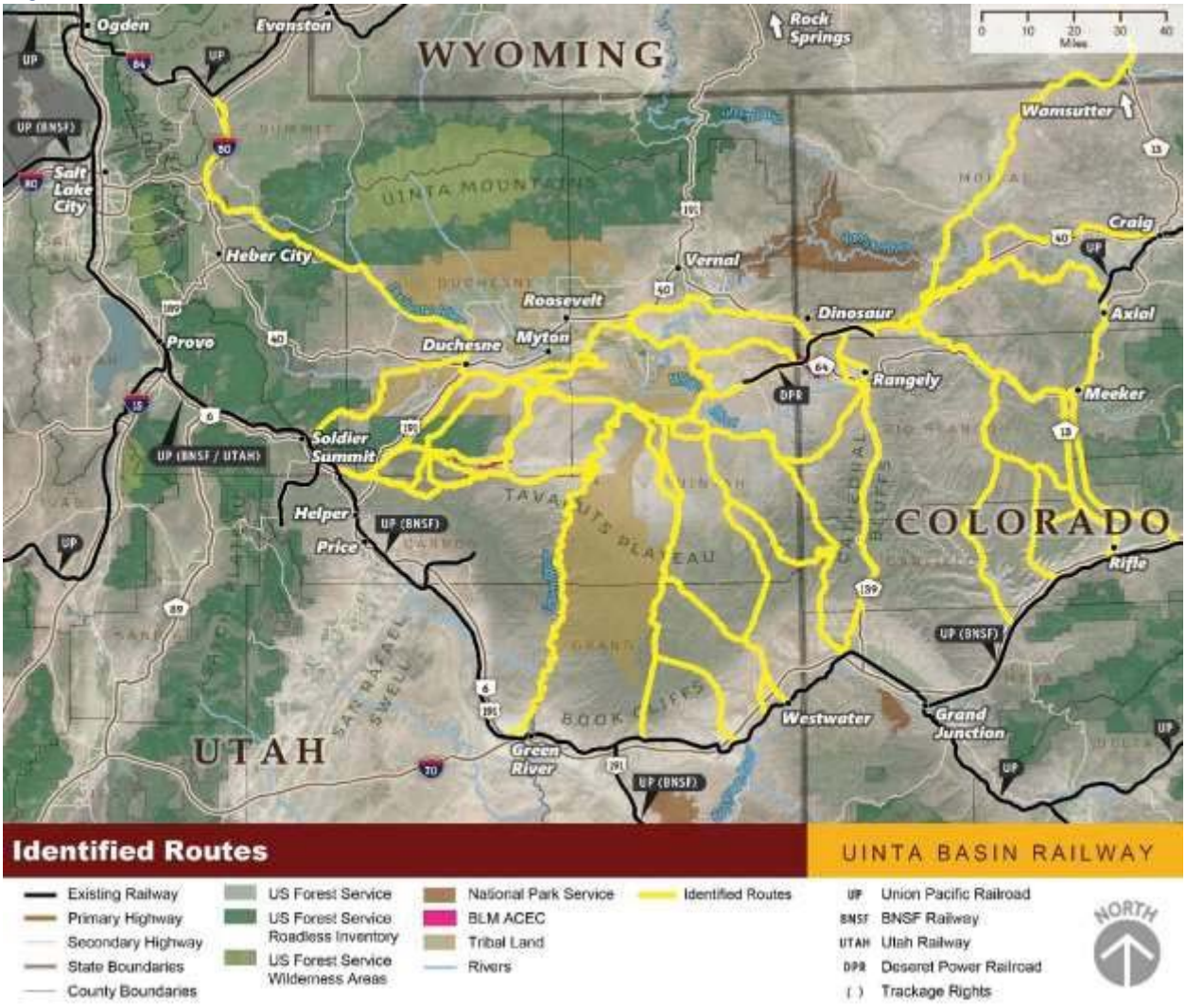
- **Operational Feasibility**: An operationally feasible route must have grades, curvature, and other design characteristics that do not exceed the criteria established in the Operational Basis of Design. The Operational Basis of Design is a document prepared for the Coalition that establishes parameters for the operations of trains on the railway.
- **Economical**: In order to meet the purpose of the project, the route selected must allow the Coalition to economically attract shippers. The ability to do this is directly tied to the cost of constructing, maintaining, and operating the railway. Generally, an economic route will (1) be shorter in length; (2) lie in flatter/less rough terrain; and (3) minimize the length of tunnels, side-hill construction (i.e., the railway embankment is placed on the sides of slopes as opposed to on valley floors or on flat ridge lines), and stream and river crossings.
- **Avoid Urban and Residential Areas**: Generally, a route that avoids urban and residential land uses is preferable.
- **Minimize Environmental Impacts**: Generally, a route that results in fewer impacts to environmental and cultural resources is preferable, and a route that utilizes to the greatest extent possible already disturbed areas is preferable.

II. Overview of Process for Evaluating Potential Routes

The Uinta Basin is bounded on all sides by high mountains or plateaus. This rugged terrain severely limits the number of potential routes that can connect the Uinta Basin to the national railway network. Generally, potential routes must either travel east or south to get out of the Basin.

HDR started its evaluation with 29 potential routes as depicted in Figure 1 below. Twenty-six of these routes were drawn from a study conducted by the Utah Department of Transportation ("UDOT") in 2014. Three additional routes were identified by HDR.

Figure 1: Identified Routes



After identification of these 29 routes, HDR began the initial screening process. Based on the screening criteria developed for the project, 21 routes were removed from further consideration as they (1) did not meet the operating parameters established in the Operating Basis of Design; (2) had a significantly higher cost of construction, compared

to the other routes; (3) ran through significantly more areas of urban and residential land use, compared to the other routes; and/or (4) ran through significantly more areas that are environmentally sensitive or have substantial cultural resources, compared to the other routes. The initial screening process is described in more detail in Section III below.

HDR then conducted a secondary screening of the eight remaining routes. For this state of screening, HDR further refined the conceptual engineering and developed an estimated conceptual construction cost for each route. In addition to estimated conceptual construction costs, HDR also collected and analyzed currently existing environmental, land ownership, and land use data for each of the eight routes. Five routes were removed during the secondary screening process. The secondary screening process is described in more detail in Section IV below.

HDR's screening process identified three potential routes for the Board's consideration. The Coalition anticipates that the Board will evaluate the feasibility of these routes, as well as the feasibility of possible alternative alignments, modifications, and refinements to minimize potential environmental impacts. After completion of scoping process and public involvement, the Coalition also recognizes that the route(s) which satisfy the project's purpose and need may evolve. The Coalition plans to continue its ongoing data collection, technical evaluations, and public outreach in order to inform the route(s) carried forward for detailed analysis in the EIS.

III. Initial Screening Process

In this initial screening process, the 29 identified routes were screened to determine if they fulfilled the criteria established in Section I. As explained above, 26 of these routes were previously identified by UDOT in 2014, and three additional routes were identified by HDR in December 2018 and January 2019. UDOT identified the 26 routes with sequential numbers 1 through 26 as shown in Table 1 below. HDR added a name to each of these 26 UDOT routes for ease in identifying its general location. Screening of the 29 routes consisted of the following process:

1. Development of Conceptual Centerlines: A conceptual route centerline was engineered for the three additional routes identified by HDR. The goal of the conceptual engineering for each route was to not exceed the vertical grade and horizontal curve maximums in the Operating Basis of Design, while seeking to reduce constructability challenges and avoid built environments and natural environments that were apparent on aerial imagery, e.g., residences, wetlands, and parks. Conceptual centerlines of the 26 UDOT routes were obtained from UDOT.

2. Visual Examination: The 29 routes were then examined by HDR for the criteria listed in Section I using visual identification of the following:

- On aerial imagery or by comparison with mapping, apparent substantial areas of natural or built environmental features, or known areas of substantial cultural resources, that were crossed or obviously impacted by the route;
- On the KMZ horizontal and vertical alignments of the railway, with comparison to aerial imagery, apparent constructability, operability, and maintainability characteristics that appeared obviously infeasible.

3. Elimination of Routes:
    - Routes failing to meet the criteria identified in Section I were eliminated from the screening process.
    - Routes also were eliminated if they were observed to be substantially duplicative to another route, but were visually observed to have substantially greater impacts on natural and built environments, or visually observed to have greater constructability and operability challenges compared to another route in the same general area.

Table 1 shows the initial screening conducted by HDR. This screening was conducted in steps, from left to right on a table. If a route failed a step, no further screening was conducted. Further discussion as to why 21 routes failed were eliminated from the screening process is discussed below Table 1.

Table 1: Initial Screening of the 29 Potential Routes

Route Alternative	Natural and Built Environment Affects	Constructability and Operational Feasibility	Not Substantially Duplicative
1 Echo			
2 Indian Canyon	✓	✓	✓
3 Sowers Canyon	✓		
4 Minnie Maud Canyon-Sowers Canyon	✓		
5 Argyle Canyon-Sowers Canyon	✓		
6 Nine Mile Canyon-Wells Draw	✓		
7 Nine Mile Canyon-Upper Green River Canyon			
8 Green River Canyon			
9 Thompson Canyon	✓		
10 Sego Canyon	✓		
11 Westwater-Seep Ridge	✓	✓	
12 Mack	✓	✓	✓
13 Mack-Evacuation Creek	✓		
14 Mack-Park Canyon	✓		
15 Douglas Pass	✓		
16 Wamsutter	✓		
17 Craig City	✓	✓	
18 De Beque	✓		
19 Parachute-Piceance Creek	✓		
20 West Rifle	✓	✓	✓
21 Parachute-Rio Blanco Pass	✓		
22 East Rifle	✓	✓	✓
23 Newcastle	✓		
24 Axial-Meeker	✓	✓	
25 Westwater	✓	✓	✓
26 Cisco	✓		
Avintaquin Canyon	✓	✓	✓
Wells Draw	✓	✓	✓
Craig	✓	✓	✓

1. Echo: Failed in Natural and Built Environment Effects Screen. This route passed through extensively developed residential areas in the Park City, Utah, area, and would likely have required relocations of residences or effects on numerous residences.

2. Indian Canyon: Passed Initial Screening.

3. Sowers Canyon: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

4. Minnie Maud Canyon-Sowers Canyon: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

5. Argyle Canyon-Sowers Canyon: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

6. Nine Mile Canyon-Wells Draw: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

7. Nine Mile Canyon-Upper Green River Canyon: Failed in Natural and Built Environment Effects Screen. This route passed through Nine Mile Canyon, an area of substantial cultural resources, and along the Green River Canyon, an area of substantial natural resources.

8. Green River Canyon: Failed in Natural and Built Environment Effects Screen. This route passed through the Green River Canyon, an area of substantial natural resources.

9. Thompson Canyon: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

10. Sego Canyon: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

11. Westwater-Seep Ridge: Failed in Not Substantially Duplicative Screen. The route is essentially identical to another route (the Westwater Route) but with higher constructability challenges due to cross-drainages on Seep Ridge.

12. Mack: Passed Initial Screening.

13. Mack-Evacuation Creek: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

14. Mack-Park Canyon: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

15. Douglas Pass: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

16. Wamsutter: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing

constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

17. Craig City: Failed in Not Substantially Duplicative Screen. The route is essentially identical to another route (the Craig Route) but with higher constructability challenges, and greater natural and built environment effects, due to it meeting the national railway network within the City of Craig.

18. De Beque: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

19. Parachute-Piceance Creek: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

20. West Rifle: Passed Initial Screening.

21. Parachute-Rio Blanco Pass: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

22. East Rifle: Passed Initial Screening.

23. Newcastle: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

24. Axial-Meeker: Failed in Not Substantially Duplicative Screen. The route is essentially identical to another route (the Craig Route) but with higher constructability challenges and greater natural and built environment effects, particularly in the vicinity of Meeker and along the White River.

25. Westwater: Passed Initial Screening.

26. Cisco: Failed in Constructability and Operational Feasibility Screen. The route required extensive tunneling, extensive embankment construction on steep slopes, and numerous stream crossings in narrow canyons, introducing constructability and maintainability challenges. Reduction of constructability and maintainability challenges would require grades in excess of the maximum established in the Operating Basis of Design.

27. Avintaquin Canyon: Passed Initial Screening.

28. Wells Draw: Passed Initial Screening.

29. Craig: Passed Initial Screening.

IV. Secondary Screening Process

HDR then refined the conceptual engineering for each of the eight routes not screened out. All eight routes commenced at the same common end points at South Myton Bench and Leland Bench, and terminated by connecting to the national railway network. For the five routes that were previously identified in the 2014 UDOT study, HDR refined the conceptual engineering to reduce length of tunnels, side-hill construction, and stream and river crossings. This in turn reduced earthwork required to construct the railway embankment, and length and number of railway bridges, and in turn that reduced construction cost and operating and maintenance costs. Routes were reduced in length during the refinement of the conceptual engineering where to do so did not either increase construction cost or exceed the parameters of the Operating Basis of Design. The refinement of conceptual engineering also sought to reduce the environmental impact of each route, based on preliminary environmental data (discussed below) for each route.

The eight routes carried forward for further evaluation are depicted in Figure 2 and described in in Table 2 below. Seven of the eight routes allow a connection to both of the two western Class I rail carriers, Union Pacific Railroad and BNSF Railway. The Craig Route allows a connection only to Union Pacific Railroad.

Figure 2: Routes Carried Forward for Further Evaluation

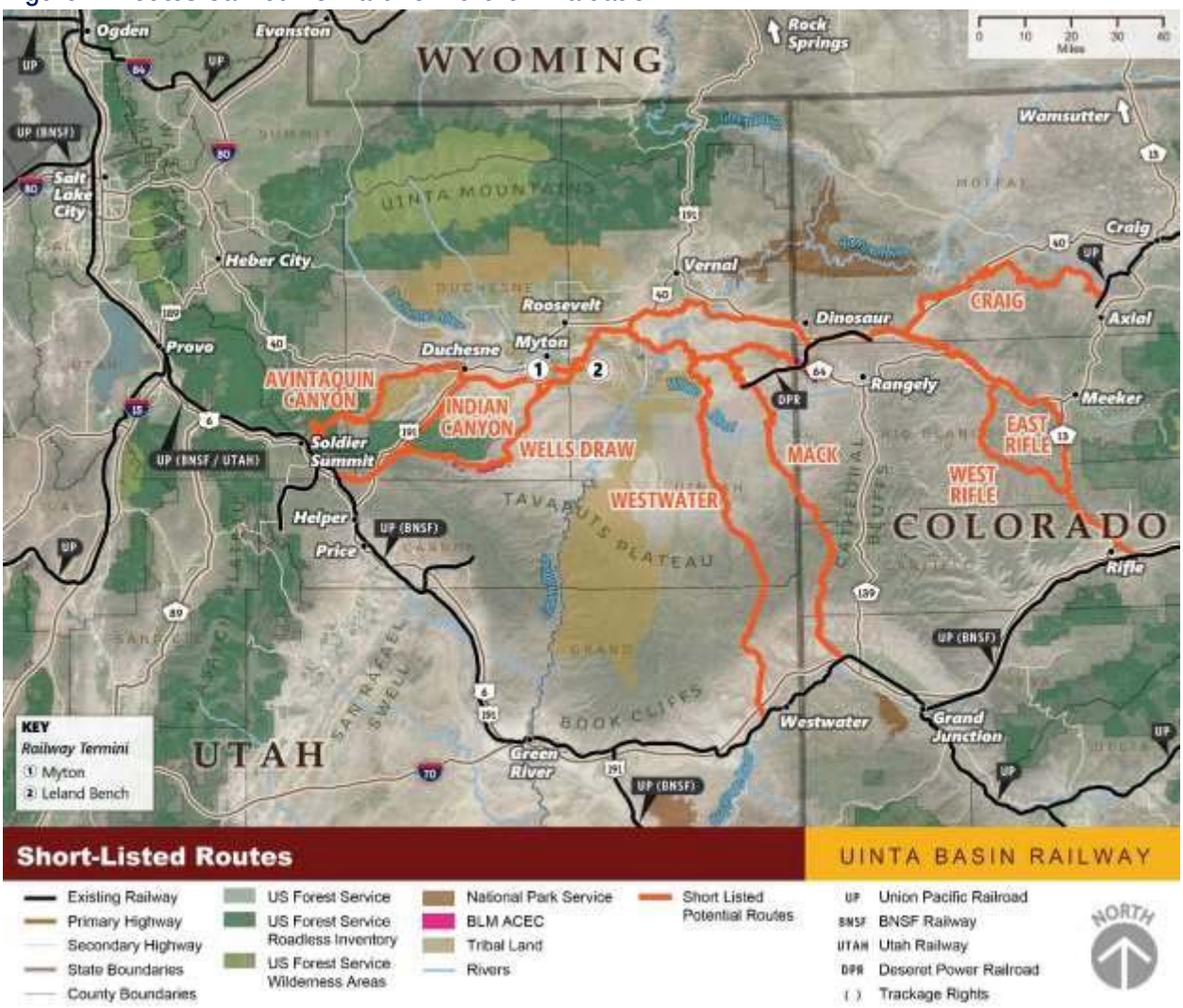


Table 2: Description of Potential Routes Carried Forward for Further Evaluation

Route Name	Description
Avintaquin Canyon	The Avintaquin Canyon Route commences at Leland Bench, approximately 9.5 miles south of Fort Duchesne, Utah. From Leland Bench, the Avintaquin Canyon Route proceeds westward, past the South Myton Bench area (approximately 3.5 miles southwest of Myton, Utah), until intersecting Indian Canyon approximately two miles south of Duchesne, Utah. After entering Indian Canyon, the route turns northward and descends to its mouth near the City of Duchesne. It then turns westward and ascends onto benchlands south of the Strawberry River until it reaches Avintaquin Canyon. It then turns southwesterly and follows Avintaquin Canyon upstream to a summit tunnel through the West Tavaputs Plateau. After exiting the tunnel, it descends the Roan Cliffs, and connects with the Union Pacific Railroad Provo Subdivision near Soldier Summit, Utah. That portion of the Avintaquin Canyon route that lies between Leland Bench and where it enters Indian Canyon is identical to the Indian Canyon Route. This route crosses Tribal Lands.
Indian Canyon	The Indian Canyon Route commences at Leland Bench, approximately 9.5 miles south of Fort Duchesne, Utah. From Leland Bench, the Indian Canyon Route proceeds westward, past the South Myton Bench area (approximately 3.5 miles southwest of Myton, Utah), until intersecting Indian Canyon approximately two miles south of Duchesne, Utah. After entering Indian Canyon, the route turns southwesterly and follows Indian Creek upstream toward its headwaters below Indian Creek Pass, paralleling U.S. Highway 191 for approximately 21 miles. The Indian Canyon Route uses a summit tunnel to pass through the West Tavaputs Plateau. After emerging from the tunnel, the route descends the Roan Cliffs to reach Emma Park, an open grassy area at the base of the Roan Cliffs. The route runs westward through Emma Park, then connects to the Union Pacific Railroad's Provo Subdivision near the railroad timetable station of Kyune, Utah. Portions of the Indian Canyon Route were identified in the 2014 UDOT Uinta Basin Railroad Environmental Study. That portion of the Indian Canyon Route between Leland Bench and where it enters Indian Canyon is identical to the Avintaquin Canyon Route, and that portion of the Indian Canyon Route between the west portal of the summit tunnel and the connection with the Union Pacific Railroad is identical to the Wells Draw Route. This route crosses Tribal Lands.
Wells Draw	The Wells Draw Route commences at two ends-of-track, one at Leland Bench (approximately 9.5 miles south of Fort Duchesne, Utah) and the other at South Myton Bench (approximately 3.5 miles southwest of Myton, Utah). These two lines meet at a junction approximately 6.5 miles south of South Myton Bench. From the junction, the Wells Draw Route runs southward, generally following Wells Draw towards its headwaters. After reaching the headwaters of Wells Draw, the Wells Draw Route turns westward and enters Argyle Canyon. The route remains on the north wall of Argyle Canyon for approximately 25 miles, eventually reaching the floor of Argyle Canyon near the headwaters of Argyle Creek. The Wells Draw Route then enters a summit tunnel through the West Tavaputs Plateau. After emerging from the tunnel, the route descends the Roan Cliffs to reach Emma Park, an open grassy area at the base of the Roan Cliffs. The route runs westward through Emma Park, then connects to the Union Pacific Railroad's Provo Subdivision near the railroad timetable station of Kyune, Utah. Portions of the Indian Canyon Route were identified in the 2014 UDOT Uinta Basin Railroad Environmental Study. That portion of the Wells Draw Route between the west portal of the summit tunnel and the connection with the Union Pacific Railroad is identical to the Indian Canyon Route. Portions of the Wells Draw Route in the vicinity of Leland Bench and South Myton Bench are identical to the Westwater, Mack, West Rifle, East Rifle, and Craig Routes. This route does not cross Tribal Lands.
Westwater	The Westwater Route commences at two ends-of-track, one at Leland Bench (approximately 9.5 miles south of Fort Duchesne, Utah) and the other at South Myton Bench (approximately 3.5 miles southwest of Myton, Utah). These two lines meet at a junction approximately 4.0 miles northwest of Leland Bench. The route proceeds northeasterly, crossing the Uinta River south of Fort Duchesne, Utah, then south-southeast to cross the Green River. It then turns south, crossing the White River, then following Bitter Creek and Sweetwater canyons to reach a summit tunnel through the East Tavaputs Plateau. After exiting the tunnel, the Westwater Route descends in East Westwater Canyon, then along Westwater Wash, exiting the Book Cliffs, then across the Green River Desert to connect to the Union Pacific Railroad's Green River Subdivision near Agate, Utah. That portion of the Westwater Route between South Myton Bench and Leland Bench, and the vicinity of the Green River crossing, is identical to the Mack Route. Portions of the Westwater Route in the vicinity of Leland Bench and South Myton Bench are also identical to the Wells Draw, West Rifle, East Rifle, and Craig Routes. Portions of this route were identified in the 2014 UDOT Uinta Basin Railroad Environmental Study. This route does not cross Tribal Lands.

Route Name	Description
Mack	The Mack Route commences at two ends-of-track, one at Leland Bench (approximately 9.5 miles south of Fort Duchesne, Utah) and the other at South Myton Bench (approximately 3.5 miles southwest of Myton, Utah). These two lines meet at a junction approximately 4.0 miles northwest of Leland Bench. The route proceeds northeasterly, crossing the Uinta River south of Fort Duchesne, Utah, then south-southeast to cross the Green River. It then turns south, crossing the White River, then following Bitter Creek Canyon to a summit tunnel through the East Tavaputs Plateau in the vicinity of Baxter Pass. From the summit tunnel, the route descends in Atchee Wash, exiting the Book Cliffs, then across Grand Valley to connect to the Union Pacific Railroad Green River Subdivision near Mack, Colorado. That portion of the Mack Route between South Myton Bench and Leland Bench, and the vicinity of the Green River crossing, is identical to the Westwater Route. Portions of the Mack Route in the vicinity of Leland Bench and South Myton Bench are also identical to the Wells Draw, West Rifle, East Rifle, and Craig Routes. Portions of this route were identified in the 2014 UDOT Uinta Basin Railroad Environmental Study. This route does not cross Tribal Lands.
West Rifle	The West Rifle Route commences at two ends-of-track, one at Leland Bench (approximately 9.5 miles south of Fort Duchesne, Utah) and the other at South Myton Bench (approximately 3.5 miles southwest of Myton, Utah). These two lines meet at a junction approximately 4.0 miles northwest of Leland Bench. The West Rifle Route then proceeds easterly, crossing the Green River approximately five miles south of Jensen, Utah. It utilizes the Deseret Power Railroad (DPR) for approximately 12.7 miles, departing from it approximately two miles west of the Deserado Mine. It then turns southeasterly, enters the White River Valley, and follows the White River upstream to the mouth of Piceance Creek. It then turns south, follows Piceance Creek upstream, crosses a ridge at the headwaters of the creek, then descends through Rifle Gap and connects to the Union Pacific Railroad Glenwood Springs Subdivision near Rifle, Colorado. The West Rifle Route is identical to the Craig Route between Leland Bench and South Myton Bench, and the connection to the Deseret Power Railroad. The West Rifle Route is identical to the East Rifle Route except between the mouth of Piceance Creek and the vicinity of Rifle Gap. Portions of the West Rifle Route in the vicinity of Leland Bench and South Myton Bench are also identical to the Wells Draw and Mack routes. Portions of this route were identified in the 2014 UDOT Uinta Basin Railroad Environmental Study. This route does not cross Tribal Lands.
East Rifle	The East Rifle Route commences at two ends-of-track, one at Leland Bench (approximately 9.5 miles south of Fort Duchesne, Utah) and the other at South Myton Bench (approximately 3.5 miles southwest of Myton, Utah). These two lines meet at a junction approximately 4.0 miles northwest of Leland Bench. The East Rifle Route then proceeds easterly, crossing the Green River approximately five miles south of Jensen, Utah. It utilizes the Deseret Power Railroad (DPR) for approximately 12.7 miles, departing from it approximately two miles west of the Deserado Mine. It then turns southeasterly, enters the White River Valley, and follows the White River upstream to a point approximately 7.0 miles west of the City of Meeker, Colorado. It then turns south, passes through Rifle Gap, and connects to the Union Pacific Railroad Glenwood Springs Subdivision near Rifle, Colorado. The East Rifle Route is identical to the Craig Route between Leland Bench and South Myton Bench, and the connection to the Deseret Power Railroad. The East Rifle Route is identical to the West Rifle Route except between the mouth of Piceance Creek and the vicinity of Rifle Gap. Portions of the East Rifle Route in the vicinity of Leland Bench and South Myton Bench are also identical to the Wells Draw and Mack routes. Portions of this route were identified in the 2014 UDOT Uinta Basin Railroad Environmental Study. This route does not cross Tribal Lands.
Craig	The Craig Route commences at two ends-of-track, one at Leland Bench (approximately 9.5 miles south of Fort Duchesne, Utah) and the other at South Myton Bench (approximately 3.5 miles southwest of Myton, Utah). These two lines meet at a junction approximately 4.0 miles northwest of Leland Bench. The Craig Route then proceeds easterly, crossing the Green River approximately five miles south of Jensen, Utah. It utilizes the Deseret Power Railroad (DPR) for approximately 12.7 miles, departing from it approximately two miles west of the Deserado Mine. It then heads generally eastward to connect to the Union Pacific Railroad Craig Subdivision near Axial, Colorado. The Craig Route is identical to the East Rifle and West Rifle routes between Leland Bench and South Myton Bench, and the connection to the Deseret Power Railroad. Portions of the Craig Route in the vicinity of Leland Bench and South Myton Bench are also identical to the Wells Draw and Mack Routes. Portions of this route were identified in the 2014 UDOT Uinta Basin Railroad Environmental Study. This route does not cross Tribal Lands. This route would allow connection to only one rail carrier, the Union Pacific Railroad.

For each of these eight routes, HDR developed an estimated construction cost. The cost of all eight routes was estimated by approximating the mileage of each route, in three terrain categories:

- **Open Terrain:** Relatively flat, agricultural, or grazing lands, such as those found in the populated and farmed areas of the Uinta Basin, in the grazing lands between Vernal and Craig, and in Emma Park. Construction in Open Terrain does not require large cuts and fills or numerous bridges, but occasional large bridges may be present. No tunnels are required.

- **Moderate Terrain:** Foothills and incised river valleys, such as those found in the vicinity of the Green River Crossing south of Vernal on the Craig Route, and in the upper reaches of Wells Draw. Construction in Moderate Terrain requires some large cuts and fills, occasional large bridges, but not numerous bridges. No tunnels are required.

- **Rugged Terrain:** Deep canyons and mountainous terrain, such as those found in the Tavaputs Plateau, Argyle Canyon, and Indian Canyon. Construction in Rugged Terrain requires many large cuts and fills, some retaining walls, and numerous bridges and multiple large bridges. Tunnels are often required in lieu of overly deep cuts or to pass through mountains that are not practical to cross in the open.

Table 3 below shows the length in miles of Open Terrain, Moderate Terrain, Rugged Terrain, and tunneling for each route.

Table 3: Types of Terrain in Miles for Potential Routes

Route	Total Mileage	Open Terrain Miles	Moderate Terrain Miles	Rugged Terrain Miles	Tunnel Miles*
Indian Canyon	80.5	60.3	0.0	17.0	4.5
Craig	185.3	155.3	30.0	0.0	0.0
Wells Draw	111.0	33.9	41.0	30.5	5.6
Avintaquin Canyon	97.3	34.4	0.0	59.0	3.9
East Rifle	196.8	132.1	0.0	63.5	1.2
West Rifle	201.6	136.9	0.0	63.5	1.2
Mack	155.0	90.4	0.0	59.5	5.1
Westwater	159.7	94.9	0.0	59.5	5.3

*Tunnel mileage is for major tunnels only, minor tunnels are incorporated into difficult terrain miles.

HDR then developed an estimated conceptual cost per mile for each of these terrain types. Generally, the Open Terrain type is the least costly per mile, while the Rugged Terrain type is the most costly per mile. An estimated conceptual cost for

tunneling was also developed for each route. This cost was based on prior tunneling projects in the Uinta Basin and Wasatch Plateau regions and high-level desktop geological and geotechnical analysis of the area. The estimated cost to construct each route did not include signaling, sidings, shipper facilities, improvements to the Union Pacific Railroad (UP), improvements to the Deseret Power Railroad (DPR), environmental mitigation, and right-of-way acquisition.

Based on HDR's estimated conceptual cost of construction, the eight routes were categorized as follows:

Lower Cost	**Middle Cost**	**Higher Cost**
Indian Canyon	Wells Draw	East Rifle
Craig	Avintaquin Canyon	West Rifle
		Mack
		Westwater

The four most costly routes—East Rifle, West Rifle, Mack, and Westwater—correspond with those having a high number of Rugged Terrain miles. This is because routing through Rugged Terrain results in more high degree curves, an increase in grades and lengths of grades, an increase in the number and length of tunnels, and higher fills and deeper cuts causing wider areas of impacts. In addition to increasing the cost of such routes, these factors also make these routes less feasible from an engineering and design perspective. While the Avintaquin Canyon Route also has a high number of Rugged Terrain miles, that route fell within the Middle Cost category because the length of the entire Avintaquin Canyon Route is significantly shorter than the East Rifle, West Rifle, Mack, and Westwater routes.

In addition to estimated conceptual construction costs, HDR also collected and analyzed currently existing environmental, land ownership, and land use data for each of the eight routes. Specifically, environmental and land use geospatial information systems (GIS) database information was obtained from existing public sources. This information included land ownership, parks, refuges, recreational areas, waterbodies, wetlands and wetland banks, historic properties, and limiting soils. The GIS data were then overlaid on each route to allow an equal comparison of the routes for the identified constraints. A corridor was developed for each route so that it included 1,000 feet of land on both sides of a particular route's centerline, for a total route corridor width of 2,000 feet. While actual project impacts will be based on further engineering refinement and field verification of the GIS data, this evaluation allowed for a preliminary high-level comparison of environmental and land use impacts among each of the eight routes. Based on this preliminary comparison, no route was identified as having significant advantages over any of the other routes from an environmental perspective. Table 4 summarizes the results of the land ownership, land use and environmental screening. Appendix A summarizes the GIS methodology to conduct the environmental screening.

Table 4: Results of Environmental Screening

Route	Land Ownership (acres)			Parks, Refuges and Recreational Areas (acres)	Number of Waterbody Crossings	Wetlands (acres)	Wetland Banks (acres)	Number of Historic Properties	Limiting Soils (Prime Farmland)[a] (acres)
	Federal	Sate	Tribal						
Indian Canyon	3,620	950	2,230	2,850[b]	157	200	0	1	1,016
Craig	19,880	3,900	0[c]	520	300	235	0	0	3,375
Wells Draw	13,570	2,000	0[c]	620	171	160	0	3	10,130
Avintaquin Canyon	3,760	418	5,420	355	185	310	0	1	1,135
East Rifle	20,480	1,523	0	600	375	561	.16	5	13,775
West Rifle	22,360	2,480	0	1,910	370	776	.16	5	13,270
Mack	18,622	2,336	0	461	260	326	.16	2	7,580
Westwater	22,480	4,700	0	1,866	287	252	0	2	6,660

a- Including Farmland of Statewide Importance and Farmland if Irrigated
b- Including U.S. Forest Service Ashley National Forest Lands
c- Corridor was clipped to remove Tribal lands

Taking into account all of these screening factors, HDR conducted the next step in the process of screening to winnow down the 8 routes. The following findings were made resulting in the identification of 3 routes for the Board's consideration:

1. The Indian Canyon and Craig routes were determined to be the most feasible from an engineering and design perspective and are the most economical routes to construct, operate, and maintain. However, Indian Canyon would allow for connection to two Class I rail carriers, while Craig would provide a connection to only one.

2. The East Rifle, West Rifle, Mack, and Westwater routes were eliminated from further consideration because they are less feasible from an engineering and design perspective (*i.e.*, go through substantially more Rugged Terrain) than the other routes, cost substantially more to construct than the Indian Canyon and Craig routes, and do not any provide any significant environmental benefits or advantages.

3. The Avintaquin Canyon Route was eliminated from further consideration because it is less feasible from an engineering and design perspective (*i.e.*, goes through substantially more Rugged Terrain) than the other routes, costs substantially more to construct than Indian Canyon and Craig, and does not provide any significant environmental benefits or advantages. The Wells Draw Route, while more costly to construct than the Indian Canyon and Craig routes, does not cross tribal land and avoids U.S. Forest Service lands. For this reason, the Coalition identified Wells Draw for further consideration as well.

4. At this time, based on the information it has collected to date, the Coalition has selected the Indian Canyon Route as its preferred route.

Appendix A

Environmental Screening GIS Methodology

This section will provide the spatial data, sources of the spatial data and methodology utilized in the environmental screening of the routes. The analysis of the data is summarized in Table 4 of the Evaluation of Potential Route Alternatives.

Spatial Data and Sources

1. **Routes**
    a. Shapefile Name: BUFFER_Routes_20190215.shp
        i. Routes Included: Indian Canyon, Wells Draw, & Craig
        ii. Geoprocessing Info: Two-thousand foot buffers created on route centerlines on 2/15/2019.
    b. Shapefile Name: BUFFER_FiveRoutes_ReEval_20181218.shp
        i. Route Included: Avintaquin Canyon, Rifle East, Rifle West, Mack & Westwater.
        ii. Geoprocessing: Two-thousand foot buffers created on route centerlines on 12/18/2018.
2. **Landownership**
    a. Shapefiles
        i. Utah: LANDOWNER_Ownership_UT.shp
            1. Source: AGRC Utah data portal
        ii. Colorado: LANDOWNER_Ownership_CO.shp
            1. Source: COMap v8 from USGS
        iii. ACEC: ACEC_Combined.shp
            1. Source: COMap v8 (USGS)(2ii) and BLM
            2. Geoprocessing: Selected any value from Name field that included "ACEC" from COMap v8 merged with BLM ACEC designated polygons for UT.
3. **Limiting Soils**
    a. Shapefile: SOIL_NRCS_Master.shp
    b. Source: NRCS Web Soil Survey
    c. Geoprocessing: Combined areas CO680, CO682, CO683, CO685, CO686, UT013, UT047, UT616, UT624 from NRCS SSURGO data to create master file for project area. Each shape was joined to related table included in the source download by the "mukey" field to the "mapunit" tabular data before being combined into master file.
4. **Waterbodies**
    a. Shapefile: WATER_NHD_Flowlines.shp
    b. Source: USGS NHD Dataset

c. Geoprocessing: Merged National Hydrography Dataset 1401, 1402, 1403, 1405, 1406 (HUC4) sub basins. These subbasins are crossed or adjacent to routes 1a & 1b.

5. **Wetlands**
   a. Shapefile: WETLANDS_Wetlands_NWI.shp
      i. Source:
      ii. Geoprocessing: Combined National Wetland Inventory 14060010, 14060007, 14060006, 14060005, 14060004, 14060003, 14050007, 14050006, 14050005, 14050002, 14050001, 14030001, 14010005 (HUC8) sub basins into master NWI dataset for the areas covered by the routes.
   b. Shapefile: LDWP_Boundary.shp
      i. Source: From UDOT 2014 Uinta Basin Environmental Study
6. **Cultural**
   a. Shapefile: CULTURAL_IndianCanyon_RangerStation.shp
      i. Source: SWCA
   b. Shapefile: CULTURAL_Escalante_Historic_Trail.shp
      i. Source: SWCA

Geoprocessing Methodology

The following is a summary of the geoprocessing steps that were conducted to calculate impacts for environmental constraints of the resource spatial data listed in 2 – 5 above. Each step identifies the geoprocessing tool used and specified parameters for each tool. A geoprocessing model was built to facilitate the workflow of sequencing the geoprocessing tasks together. An example model is shown in Figure 1.

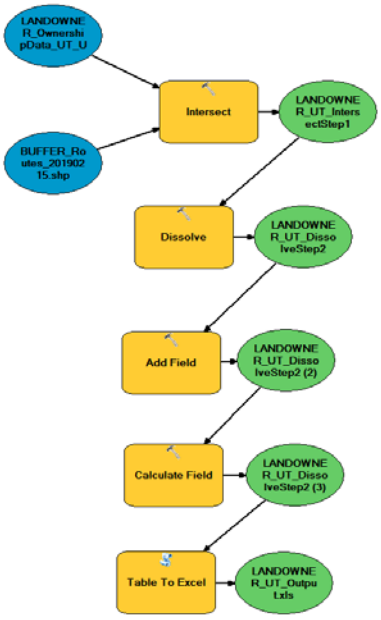


Figure 1: Example Model

   a. Clip: Data clipped to Utah and Colorado state boundaries
      i. Data Input:
         1. Waterbodies and Wetlands
         2. CO and UT State Boundaries
   b. Intersect: Route polygon features 1a & 1b with each individual landownership datasets in 2a.
      i. Data Input:
         1. Routes 1a & 1b, Landownership 2Ai-iii.
   c. Dissolve: Each layer below was dissolved using the identified parameters.
      i. Input Feature: LANDOWNER_Ownership_UT
         1. Parameters: Dissolved Fields "AGENCY", "DESIG", "Route"
      ii. Input Feature: LANDOWNER_Ownership_CO
         1. Parameters: Dissolved Fields "MANAGER", "MGMT_DESCR", "Route"
      iii. Input Feature: ACEC_Combined
         1. Parameters: Dissolved Fields "ACEC_NAME", "ADMIN_ST", "Route"
      iv. Input Feature: SOIL_NRCS_MASTER
         1. Parameters: Dissolved Fields "farmlndcl", "State", "Route"

v. Input Feature: WATER_NHD_Flowlines
    1. Parameters: Dissolved Fields “Route”
vi. Input Feature: WETLANDS_Wetlands_NWI
    1. Parameters: Dissolved Fields “WETLAND_TYPE”, “Route”
vii. Input Feature: LDWP_Boundary
    1. Parameters: Dissolved Fields “UNIT”, “Route”

d. Add Field
    i. Landownership, ACEC, Soil, Wetlands
        1. Add Field “Acreage”
    ii. WATER_NHD_Flowlines
        1. Add Field “Length”
e. Calculate Field
    i. Calculated using Python 9.3
        1. Acreage= !shape.area@acres!
        2. Length= !shape.length@feet!
    ii. Coordinate System: Utah State Plan Central FIPS 4302
f. Table To Excel Export

Cultural Resources Methodology

Below is a summary of the geoprocessing steps conducted to specifically for cultural resources

1. Select by Location
    a. Input: CULTURAL_Escalante_Historic_Trail.shp
        i. Geoprocessing: Select by location of intersections between routes 1a & 1b with input data and calculated a total count.
    b. Input: CULTURAL_IndianCanyon_RangerStation.shp
        i. Geoprocessing: Select by location of intersections between routes 1a & 1b with input data and calculated a total count