Tables

Table 2.17 Reliance No. 11 South: Basin Physical Properties

Basin Name	watershed area (ac.)	addn'l watershed area (ac.)	valley length (ft.)	drainage density (ft./ac.)	head elev (ft.)	base elev (ft.)	total relief (ft.)	head slope	base slope
Main	36.37	27.62	1813.57	184.88	6,880.46	6,772.00	108.46	-13%	-2%
L-1	12.80	0.00	1062.05	194.40	6,883.28	6,810.44	72.84	-7%	-4%
L-2	12.70	3.46	1001.36	190.64	6,835.42	6,773.21	62.22	-12%	-2%
L-1 R1	7.88	13.97	972.16	181.08	6,893.80	6,819.01	74.79	-12%	-5%
L-1 R1 L1	2.63	1.86	454.11	172.67	6,894.85	6,837.11	57.74	-13%	-6%
L-2 L1	3.30	3.74	655.10	198.78	6,836.00	6,797.38	38.62	-10%	-5%
L-2 R1	4.67	0.00	765.28	163.94	6,835.29	6,790.26	45.03	-12%	-6%
TOTAL	**80.35**	**50.65**							

Table 2.18 Reliance No. 11 South: Drainage Runoff Parameters

Basin Name	Bank-full Conditions*				Flood-prone Conditions**			
	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)
Main	0.07 to 6.69	0.01 to 0.42	0.06 to 1.33	19.58	0.16 to 12.66	0.02 to 1.22	0.09 to 1.90	65.27
L-1	0.40 to 3.91	0.04 to 0.39	0.19 to 1.19	6.89	0.94 to 9.07	0.11 to 1.04	0.28 to 1.71	22.97
L-2	0.06 to 4.34	0.01 to 0.35	0.05 to 0.77	6.84	0.15 to 9.09	0.02 to 0.94	0.08 to 1.11	22.80
L-1 R1	0.30 to 3.07	0.03 to 0.31	0.24 to 1.07	4.24	0.69 to 7.12	0.08 to 0.81	0.34 to 1.54	14.14
L-1 R1 L1	0.44 to 1.77	0.04 to 0.18	0.39 to 1.07	1.42	1.03 to 4.11	0.12 to 0.47	0.57 to 1.54	4.72
L-2 L1	0.31 to 1.99	0.03 to 0.20	0.13 to 0.71	1.77	0.72 to 4.6	0.08 to 0.53	0.15 to 1.02	5.91
L-2 R1	0.42 to 2.61	0.05 to 0.21	0.16 to 0.67	2.51	0.89 to 5.48	0.09 to 0.63	0.26 to 0.95	8.38

Table 2.19 Reliance No. 11 South: Existing Offsite Impoundment Peak Flow and Discharge

	Surface Area	Peak Flow (cfs)	Discharge (cf)	Discharge (cy)	Discharge (ac-ft)
Existing Offsite	22.9	51.3	118078	4373	2.7
Total	**22.9**	**51.3**	**118078**	**4373**	**2.7**

Table 2.20 Reliance No. 11 South: Main Pond 1 Peak Flow and Discharge

	Surface Area	Peak Flow (cfs)	Discharge (cf)	Discharge (cy)	Discharge (ac-ft)
South Main Area	59.8	115.4	265473	9832	6.1

Table 2.21 Reliance No. 11 South: Pond 2 Peak Flow and Discharge

	Surface Area	Peak Flow (cfs)	Discharge (cf)	Discharge (cy)	Discharge (ac-ft)
South Minor Area	42.0	81.1	186439	6905	4.3

Table 2.22 Reliance No. 11 South: South Spoils Physical Properties

Basin Name	watershed area (ac.)	addn'l watershed area (ac.)	valley length (ft.)	drainage density (ft./ac.)	head elev (ft.)	base elev (ft.)	total relief (ft.)	head slope	base slope
Main	8.14	0.00	603.51	139.23	6,829.63	6,740.00	89.63	-14%	-8%
L-1	4.23	2.43	530.24	125.42	6,880.72	6,752.39	128.33	-22%	-14%
TOTAL	**12.37**	**2.43**							

Table 2.23 Reliance No. 11 South: South Spoils Runoff Parameters

Basin Name	*Bank-full Conditions**				*Flood-prone Conditions***			
	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)
Main	0.10 to 3.12	0.01 to 0.31	0.09 to 2.72	4.38	0.23 to 7.24	0.03 to 0.83	0.13 to 3.9	14.62
L-1	0.31 to 2.25	0.03 to 0.22	0.47 to 2.93	2.28	0.72 to 5.21	0.08 to 0.60	0.68 to 4.2	7.59

3.0 Reliance No. 3 and Lionkol Main Pits: Design Summary

Figure 13: Reliance No.3 Before and After Construction

Figure 14: Lionkol Pits Before and After Construction

The AML Project 17H-2B-II, Reliance No. 3 and Lionkol Main Pits reclamation area addressed two separate coal mine areas primarily using NR design software with a minimal amount of traditional reclamation techniques. The project areas are shown in Figure A-1.2 in Appendix A1.

This was the third design project completed by BRS utilizing the NR software. Previous projects included AML Project 16N-3 Central Spoils and AML 17H-2B Reliance No. 11 Pits as described above. For both of the prior projects, design work was completed such that the recommended Shields shear stress channel stability criteria of less than 1.0 psf for the bank full flow condition and less than 1.5 psf for the flood prone flow conditions were achievable through the software. For the AML 16N-3 project, this was accomplished through the use of multiple small basins with moderate vertical relief. For the 17H-2B project design on the Reliance No. 11 North and South Pit areas, shear stresses were minimized through the incorporation of traditional reclamation structures and concepts combined with NR channels to decrease flow quantities and velocities. For the 17H-2B-II project at Reliance No. 3 and Lionkol Pits, a new design approach was implemented. The basic conceptual approach was to restore each of the disturbed areas to approximate pre-mine contours and drainage configurations. When the initial NR designs were developed for some of the project areas, it was found that the design Shields shear stresses were well in excess of the stability criteria recommended for use in NR.

In multiple areas of the project, the Reliance No. 3 Pit area in particular, it was clear that the designed main channel grades, basin areas, and alignments were very close representations of the pre-mine configuration. It is likely that the design created a surface that was more stable and conservative than the pre-mine surface as the channel sinuosity utilized in the design was high, and no similar channels with high sinuosity have been observed in the region of the project. Nicholas Bugosh, the creator of the GeoFluv approach which was used to develop the NR software, was contacted to discuss design issues. Questions regarding the stability criteria, allowable shear stresses, and natural channel stabilities were discussed. While Mr. Bugosh declined to directly answer the questions of allowable shear stresses and the stability criteria, he stated that NR was intended to mimic the surrounding native system as closely as possible. It was discussed that if a native channel is found to be erosive due to factors such as relief, gradient, site materials, and precipitation, it may throw the overall channel out of natural equilibrium if the reclaimed channel reaches were constructed to be less erosive. The analogy that has been used in the past to describe this concept is the idea of grabbing a snake in the middle. While there is control of the snake at the point it is grasped, both ends above and below the location it is gripped are still uncontrolled and capable of damaging other areas. If the reclaimed channel is constructed with significantly higher stability than the incoming and outgoing native channel reaches, it is likely that deposition would occur in the upper portion of the project where the flow from native is suddenly slowed, losing the energy to keep sediment in suspension. On the downstream end of the project, flow from the overly stable reclaimed area would exit the project with minimal sediment in suspension. Upon encountering the less stable native channel, the water would accelerate and begin to erode the native channel in an effort to achieve balance between the flow energy and the ability to transport sediment. In support of this line of thought, it was discussed that while the Shields shear stresses indicate the size of particles that can be brought into motion by a shear of a particular magnitude, it provides no information on the distance that particle may be transported or the quantity of particles of a similar size that may be transported, factors which would affect the amount of erosion a channel may experience. Excessive quantities of materials transported large distances would be perceived as channel failure due to erosion, but a moderate, even progress of sediment through the system would be perceived as normal and healthy channel development. As a result, if the reclaimed channel reaches are designed such that they match the native channel grades, cross sections, and stability parameters, in theory the sediment transport through the site would match the approximate particle quantities in motion above and below the project area, neither creating erosion or allowing deposition, and appearing stable through time as uniform quantities of sediment are conveyed through the native and reclaimed channel reaches.

Ultimately the design approach was to develop a design which matches the native system as closely as possible. This meant accepting the higher shear values reported by the software as representative of the native system and not as an indication that unacceptable erosion would occur in the channel upon completion of the project. AML understood the risks in proceeding under these assumptions, and was willing to do so to advance the application and understanding of the NR methods for future projects. It was discussed that if the channels failed with unacceptable levels of erosion, it may be necessary to complete some remedial work on the project such as adding traditional runoff attenuation impoundments and riprap structures similar to the 17H-2B Reliance No. 11 project; as in Section 2.0 above. However, to date this design determination has proved to be adequate as shown by recent site inspections, indicating that the majority of the constructed channel reaches do not have unacceptable levels of erosion occurring on site.

Recent work with alternative methods of precipitation estimation as discussed in Section 4.0 suggest that the conservative precipitation and runoff methods utilized by NR may have contributed to the high reported shears for this project. Actual site conditions may show significantly lower runoff quantities and corresponding shear values from contributing drainage areas, which may be more effectively modeled by regional regression equations (i.e. Miller, 2003).

Four separate NR projects were completed for the Reliance No. 3 basins shown in Figure A-3.1, Figure A-3.2, Figure A-3.3, Figure A-3.4, Figure A-3.5, and Figure A-3.6, in Appendix A3.2 and another 12 NR projects were completed for the Lionkol Main Pit, Lionkol Lower Pit, and Lionkol Lower Spoils as shown in Figure A-3.7, Figure A-3.8, Figure A-3.9, Figure A-3.10, Figure A-3.11, Figure A-3.12, and Figure A-3.13 in Appendix A3.3. The individual basins were combined in ACAD to create the final design surfaces. The NR channel hydrologic and physical properties will be discussed in the Section 3.2.

One surface water attenuation impoundment was constructed for this project at the Lionkol Lower Spoils. This impoundment has a very small capacity, and was primarily constructed to prevent sedimentation of the culvert outlet which discharges the overflow to the main Lionkol drainage. Three riprap erosion grade control structures were installed at the Reliance No. 3 Project site. Two are at the head of the channel of the Main Valley and Valley 2. These were installed to prevent any potential failure within the project area from progressing upstream into undisturbed native ground. The third was installed at the confluence of the Main Valley and Valley 2 to prevent potential headward erosion from the Outlet Channel. A large drop structure was constructed at the discharge of the Outlet Channel, where downstream channel degradation required a drop to allow the reconstructed channel to achieve relatively stable gradients. A drop structure was also constructed at the Lionkol Lower Spoils to transition an “A” channel into the main Lionkol Drainage. A detailed description of each of the hydrologic design elements follows by area in the subsequent sections.

Following the construction phase, agronomic activities were completed on the disturbed areas from both the 17H-2B and 17H-2B-II projects in the fall of 2009. This included the application of fertilizer, gypsum and granular humic acid, hauling and spreading of manure, discing in of the manure and other soil amendments, drill seeding, and mulching and crimping grass hay in an effort to promote revegetation in this arid area characterized by poor soils and minimal native vegetation.

Figure 15: Native Grasses Re-establishing at Reliance No. 3

3.2 Reliance No. 3: Hydrologic Features Summary

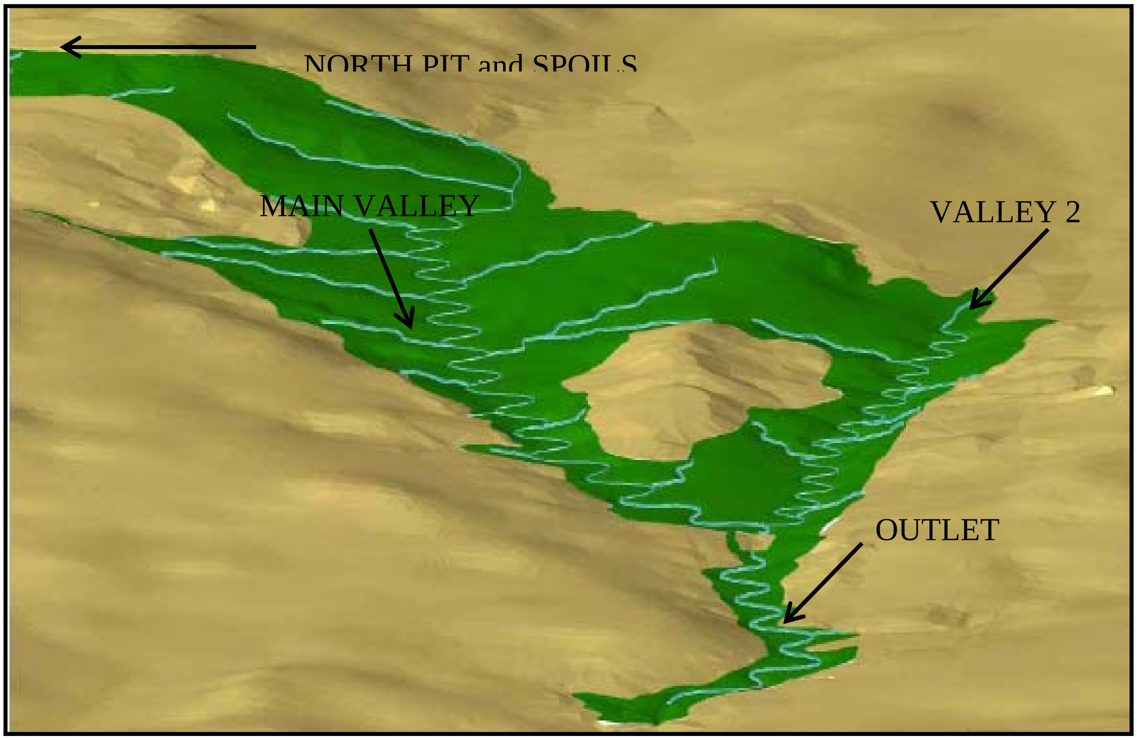


Figure 16: Reliance No. 3 Design 3-Dimensional Rendering

3.2.1 Reliance No. 3: Geomorphic Channels

Four separate NR basins were modeled for the Reliance No. 3 area design as shown on Figure A-3.1 in Appendix A3.2. The first basin, which drains the largest portion of the pit area, is labeled the Main Valley. A large tributary basin to the south of the main valley was labeled as Valley 2. These two primary drainages are joined at a confluence at the east end of the pit area, where they are conveyed through a short section of well vegetated stable channel which was not disturbed by the mining or reclamation activities. The combined flows are then conveyed off site through the Outlet Channel. Additional small grading areas include the North Pit and the North Spoils. Main, Valley 2, the Outlet Channel, the North Pit, and the North Spoils are described in subsequent sections.

The physical properties of the Main Valley basin are shown in Table 3.1. The total basin area for the Main Valley was 223 acres. The Main Valley drainage is extensive; over a mile long with approximately 365 feet of vertical relief, and has additional contributing area of 109 acres. A total of 14 tributary channels are connected to the Main channel, with an additional 3 secondary tributaries adding to the dendritic drainage pattern. The design runoff parameters are shown in Table 3.2. Included in this table are the design Shields shear stresses for both the bank full condition and the flood prone condition. Many of the channel shear ranges are in excess of Carlson software's recommended stability criteria for shear. The channels which exceed the values for the maximum shears are the Main Channel, L7, R4, and R12. For L7, high shears are primarily related to steep channel gradients. High shears on R4 are related to low drainage density and steep channel gradients. For the Main channel and R12, high shears are related to large contributing areas, and thus large flows. Due to the volume of data, detailed data for Shields shear values by station are not included in this report but are available upon request.

The physical properties of the Valley 2 basin are shown in Table 3.3. The total basin area for Valley 2 was 101 acres. Valley 2 is nearly as extensive as the Main basin, just under a mile long with approximately 300 feet of vertical relief. Valley 2 has an additional acreage of 109 acres of contributing basin area. A total of 9 tributary channels enter the Valley 2 main channel. The design runoff parameters, including the Shields shear stresses, are shown in Table 3.4. The channel shear ranges for the smaller tributary channels are at or below the recommended shear values, while the main channel and larger tributaries are in excess of the recommended maximum shear values.

The local basin area for the Outlet Channel is 86 acres, which includes one tributary channel draining 65 acres from the south. Another 370 acres of contributing area enters the head of channel from the Main and Valley 2 basins described above. The physical properties of the Outlet Channel are shown in Table 3.5. At the time the designs were completed this was the largest basin area conveyed by a NR channel constructed for AML. The Outlet Channel basin is approximately 1400 feet in length with 40 feet of vertical relief. The design runoff parameters are shown in Table 3.6. The channel shears are nearly double the recommended shear ranges, and the difference between the high to low shear values is minimal. The runoff experienced by this channel is driven primarily by the contributing area flows.

The physical properties of the North Pit are shown in Tables 3.7. The local basin area for the North Pit was 3.7 acres. The reclamation design included a main channel with one tributary channel draining 1.3 acres from the south. This drainage is a small, uplands area. The North Pit basin is approximately 588 feet long with 39 of vertical relief. The design runoff parameters are shown in Table 3.8. The channel shears are less than the maximum recommended shear ranges due to the small basin areas for this site.

The physical properties of the North Spoils are shown in Tables 3.9. The local basin area for the North Pit was 4.5 acres. The total contributing area entering the North Spoils basin at the head of channel is 12.9 acres, which includes the North Pit, separated by a reach of undisturbed channel. The North Spoils basin is approximately 484 feet long with 54 feet of vertical relief. The design runoff parameters are shown in Table 3.10. The channel shears are in excess of the recommended shear ranges due to the contributing basin area.

3.2.2 Reliance No. 3: Riprap Structures

The United States Army Corps of Engineers Steep Slope Riprap Design Method was utilized for the sizing of the riprap to be utilized in the outlet and drop structures. This is a conservative method which over-sizes the rock with multiple safety factors built into the formulas. Design peak discharges were based upon the TR-55 method for estimating discharges utilizing ACAD Land Desktop's hydrology module. A 100-year, 24-hour storm event was used to calculate the design discharge for the riprap structures.

Riprap grade control structures GC-2 and GC-3 were constructed at the inlets of both the Main channel and Valley 2 as shown on Figure A-3.2 and Figure A-3.3 in Appendix A3.2. In addition, a grade control structure GC-4 was constructed below the confluence of the Main channel and Valley 2 where they discharge into the Outlet Channel, and a drop structure, Drop 1 was constructed of class 36 riprap, where the Outlet Channel discharges into the eroded channel downstream of the site. A smaller drop structure, Drop 2, was required to tie in the R12 tributary to the Main channel based upon existing site gradients, and GC-1 was installed where R13 entered the Main channel. The design discharges for each structure are shown in Table 3.11. The grade control structures were constructed of class 15 riprap produced on site, except for GC-1 which utilized class 6 riprap. Drop 1 on the outlet channel required Class 36 riprap, which was salvaged on-site. Drop 2 was constructed of class 6 riprap from the Pete Lien quarry near Rawlins, WY. The dimensions and quantities of the outlet structures are shown in Table 3.12.

3.2.3 Reliance No. 3: Performance Evaluation

A field inspection of the channels on the Reliance No. 3 area was completed in late July and early August 2013. The site was re-vegetated in the fall of 2009, providing four full growing seasons for vegetation to establish. General performance of the geomorphic channels was in line with the expected behaviors of naturally establishing channels and is similar to that of both Reliance No.11 sites (see Section 2.2.6 for summary). Vegetation was observed to be limited to small communities located in depressions, sheltered areas, and along channel flow-lines and banks, all areas which focus and gather water from runoff and snowmelt needed in this arid climate.

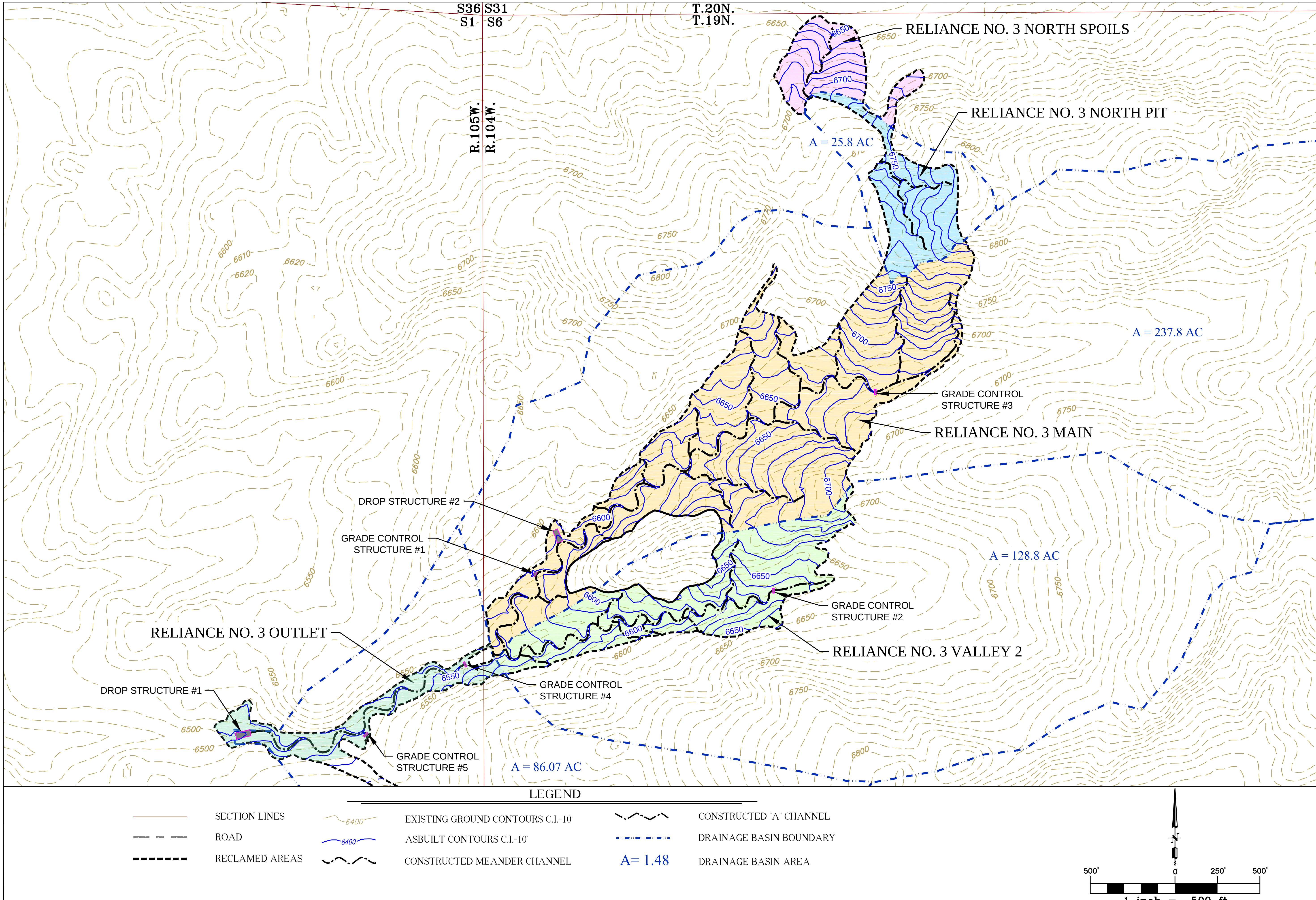
The largest failure requiring repair was along the main channel of the North Spoils (see as-built drawing in Appendix A3.2). The channel was incised between 6 and 18 inches in depth along its length, and had several meander bends completely shortcut by pilot channel formation. Following unusually high precipitation in October 2013, some of the channels cutting through the meander bends of the channel had self-repaired. However, since the channel was designed with high Shields shear stresses (1.68-2.34psf at bank-full and 2.56-3.56psf at flood-prone) and that the erosion in the remainder of the channel had not self-corrected, the entire channel needed to be widened to prevent continued focusing of flow in the pilot channel. As such, the channel was repaired on October 29th, 2013 using a dozer to widen and reinforce the channel.

Figure 17: Reliance No. 3 North Spoils Main Failure: Channel cutting through point bar

Despite high designed Shields shear stresses within the Reliance No.3 Main area channels L7, R12, R4 and main channels (see as-built drawings in Appendix A3.2), the channels were found to be performing well and did not require repair. The Reliance No.3 Valley 2 basin channels behaved equally well. Although a handful of channel lengths exhibited pilot channel formation of up to 18 inches in depth, they were typically less than 20 feet in length and were deemed not in need of repair.

The outlet of the Main and Valley 2 basins also had high design Shields shear stresses (3.42 - 3.89 psf under flood-prone conditions). However erosion was confined between the riprap structures (see as-built drawings in Appendix A3.2). Water exiting the upstream riprap structure was “hungry” or devoid of sediment load and was cutting a 12 inch pilot channel into the downstream channel, then re-depositing it down-gradient into the downstream riprap structure. It was concluded that as the voids between rocks in the riprap structure fills with sediment, the flow of water and sediment will stabilize and, therefore was not in need of repair.

Other, smaller failures within the northern area of the Reliance No.3 site were largely due to the construction of short channel lengths above the natural surface grade. The North Pit Main was found to have a 15 foot long segment of channel incised with a 2.5 feet deep pilot channel. Due to the small size and cause of the failure, the channel is expected to be self-correcting and was not repaired.



RELIANCE NO.3 OVERALL MAP

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

FIGURE A-3.1

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

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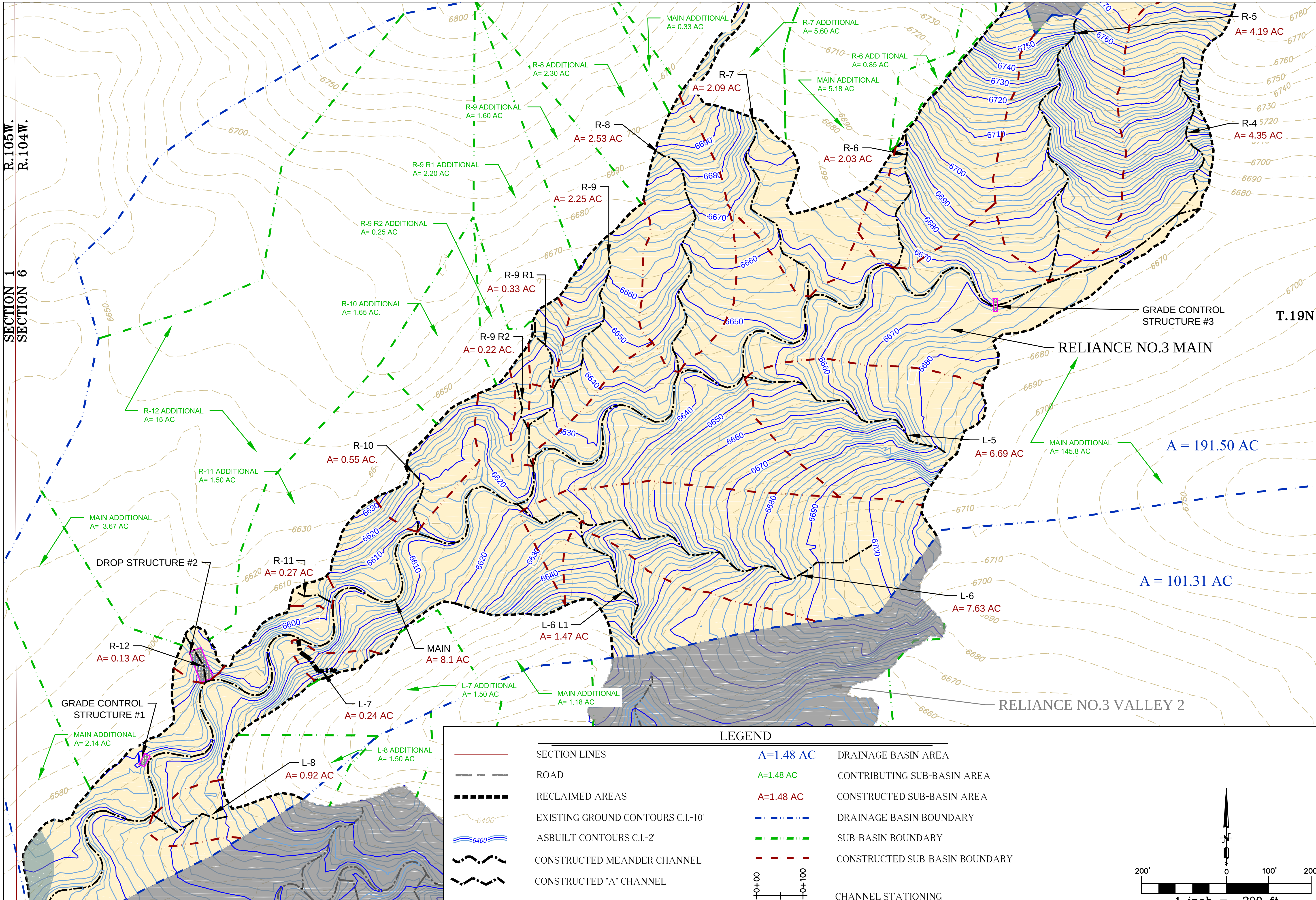

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LAST PLOT DATE: 3/25/14

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LIONKOL AREA GEOMORPHIC RECLAMATION

AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV

SWEETWATER COUNTY WYOMING

RELIANCE NO.3 MAIN

FIGURE A-3.2

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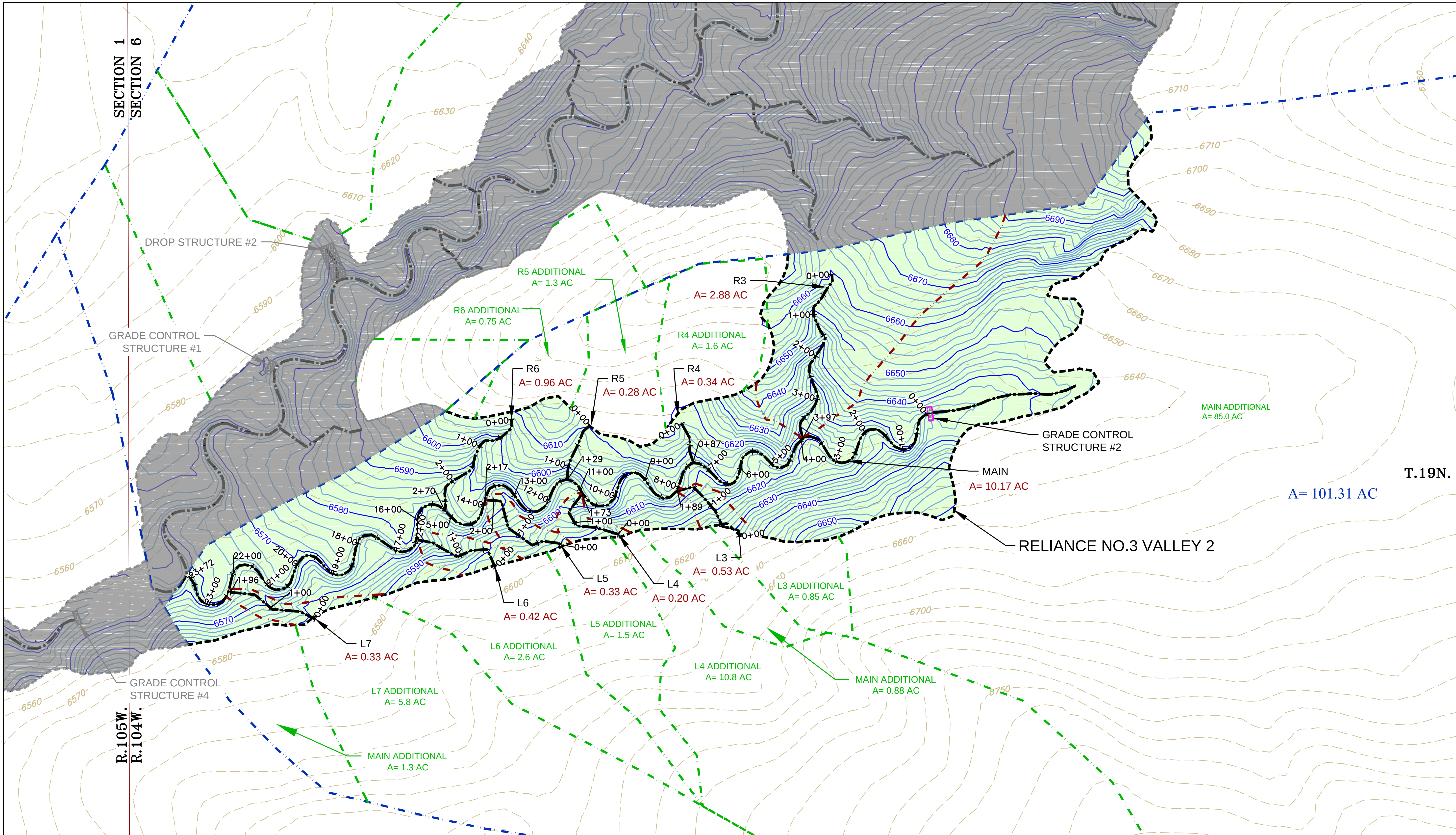

LEGEND

	SECTION LINES		ASBUILT CONTOURS C.I.-2'		DRAINAGE BASIN BOUNDARY
	ROAD		CONSTRUCTED MEANDER CHANNEL		SUB-BASIN BOUNDARY
	RECLAIMED AREAS		CONSTRUCTED "A" CHANNEL		CONSTRUCTED SUB-BASIN BOUNDARY
6400	EXISTING GROUND CONTOURS C.I.-10'	A=1.48 AC	DRAINAGE BASIN AREA	0+00 0+100	CHANNEL STATIONING
		A=1.48 AC	CONTRIBUTING SUB-BASIN AREA		
		A=1.48 AC	CONSTRUCTED SUB-BASIN AREA		

200' 0 100' 200'

1 inch = 200 ft

BRS ENGINEERING

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LAST PLOT DATE: 3/24/14

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LIONKOL AREA GEOMORPHIC RECLAMATION AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV SWEETWATER COUNTY WYOMING

RELIANCE NO.3 VALLEY 2

DWG. NO. FIGURE A-3.3

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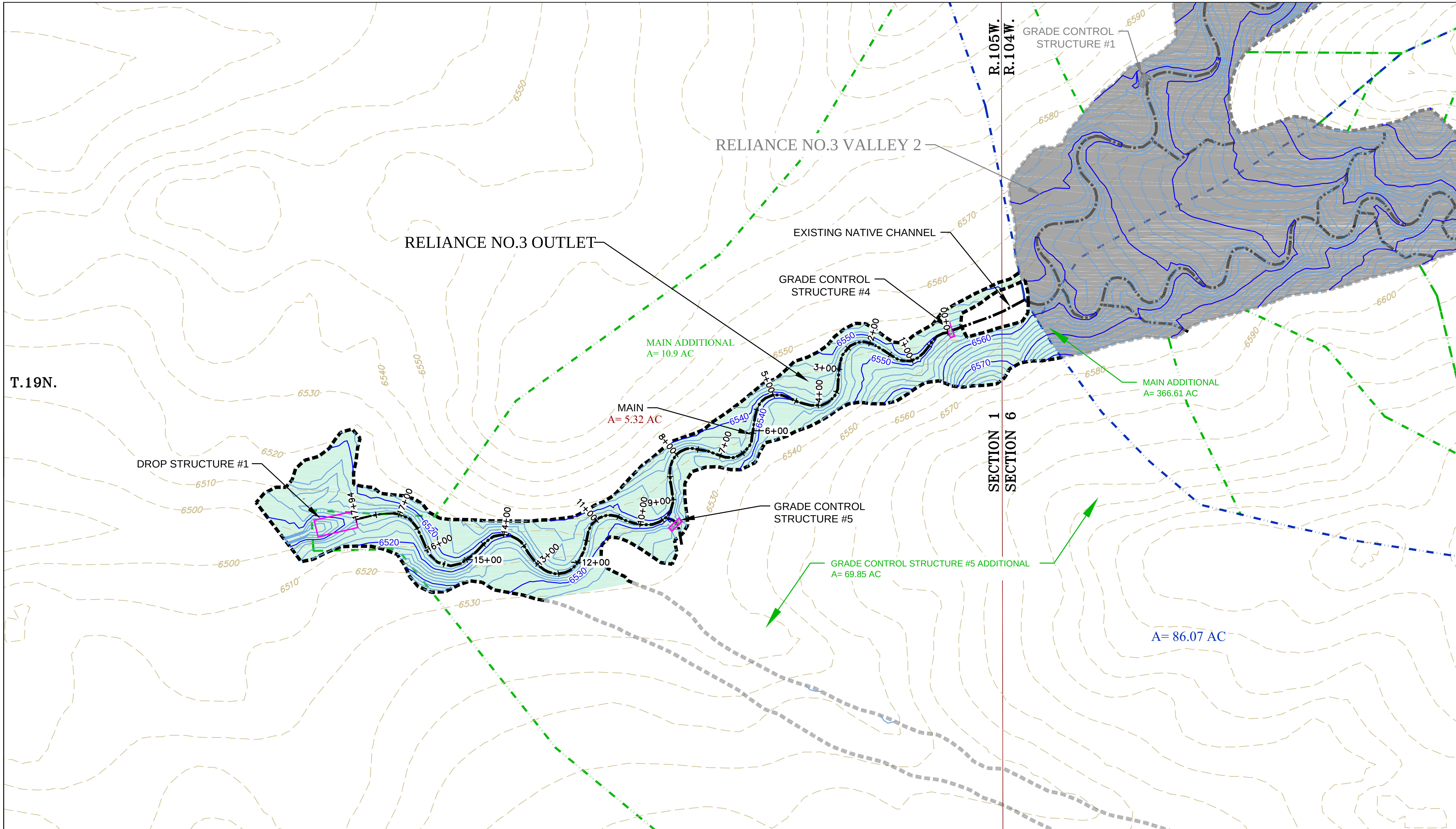

LEGEND

SECTION LINES		CONSTRUCTED MEANDER CHANNEL		A=1.48 AC	DRAINAGE BASIN AREA
ROAD		CONSTRUCTED "A" CHANNEL		A=1.48 AC	CONTRIBUTING SUB-BASIN AREA
RECLAIMED AREAS		0+00 0+100	CHANNEL STATIONING	A=1.48 AC	CONSTRUCTED SUB-BASIN AREA
6400	EXISTING GROUND CONTOURS C.I.-10'				DRAINAGE BASIN BOUNDARY
6400	ASBUILT CONTOURS C.I.-2'				SUB-BASIN BOUNDARY
					CONSTRUCTED SUB-BASIN BOUNDARY

N

200' 0 100' 200'

1 inch = 200 ft

BRS ENGINEERING

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

LAST PLOT DATE: 3/24/14

CAD FILENAME: NATURAL REGRADE PROJECTS/RELIANCE 3/FIG A-3.4 Reliance 3 Outlet.dwg

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

RELIANCE NO.3 OUTLET

DWG. NO. FIGURE A-3.4

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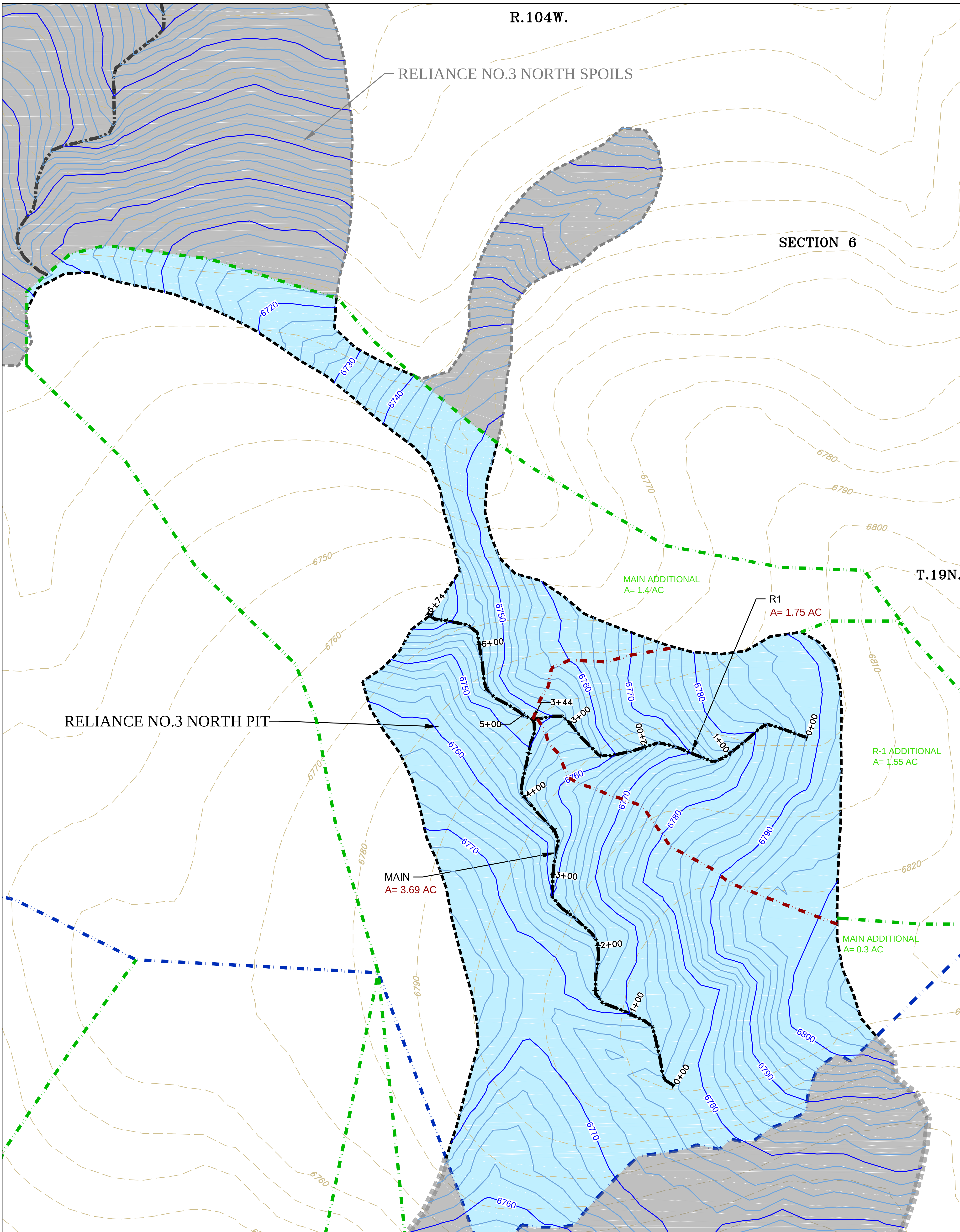
DATE 3/24/14



LEGEND

	SECTION LINES	A=1.48 AC	DRAINAGE BASIN AREA
	ROAD	A=1.48 AC	CONTRIBUTING SUB-BASIN AREA
	RECLAIMED AREAS	A=1.48 AC	CONSTRUCTED SUB-BASIN AREA
6400	EXISTING GROUND CONTOURS C.I.-10'		DRAINAGE BASIN BOUNDARY
6400	ASBUILT CONTOURS C.I.-2'		SUB-BASIN BOUNDARY
	CONSTRUCTED MEANDER CHANNEL		CONSTRUCTED SUB-BASIN BOUNDARY
	CONSTRUCTED "A" CHANNEL		

0+00 0+100 CHANNEL STATIONING

N

100' 0 50' 100'

1 inch = 100 ft

RELIANCE NO.3 NORTH PIT

SCALE: 1" = 100' DATE 3/24/14
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APPROVED: HH

DWG. NO. FIGURE A-3.5 REV.

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

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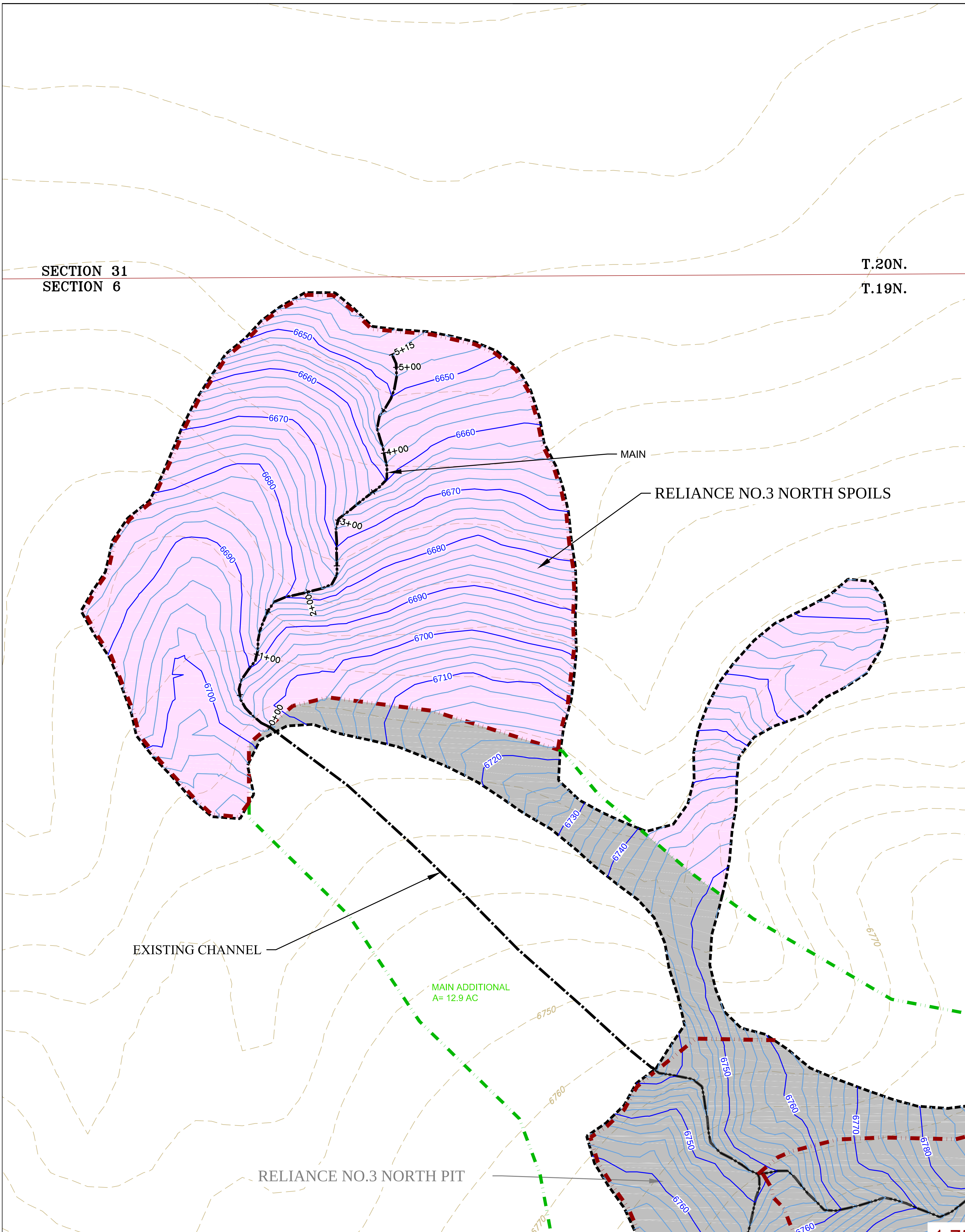

LEGEND

SECTION LINES		A=1.48 AC	DRAINAGE BASIN AREA
ROAD		A=1.48 AC	CONTRIBUTING SUB-BASIN AREA
RECLAIMED AREAS		A=1.48 AC	CONSTRUCTED SUB-BASIN AREA
EXISTING GROUND CONTOURS C.I.-10'			DRAINAGE BASIN BOUNDARY
ASBUILT CONTOURS C.I.-2'			SUB-BASIN BOUNDARY
CONSTRUCTED MEANDER CHANNEL			CONSTRUCTED SUB-BASIN BOUNDARY
CONSTRUCTED "A" CHANNEL			

0+00 0+100 CHANNEL STATIONING

100' 0 50' 100'

1 inch = 100 ft

RELIANCE NO.3 NORTH SPOILS

SCALE: 1" = 100'
DATE 3/24/14
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APPROVED: HH

DWG. NO. FIGURE A-3.6
REV.

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

LAST PLOT DATE: 3/24/14

CAD FILENAME: NATURAL REGRADE PROJECTS/RELIANCE 3/FIG A-3.6 Reliance 3 North Spoils.dwg

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Tables

Table 3.1 Reliance No. 3: Main Basin Physical Properties

Basin Name	Watershed Area (ac.)	Addn'l Watershed area (Ac)	valley length (ft.)	drainage density (ft./ac.)	head elev (ft.)	base elev (ft.)	total relief (ft.)	head slope	base slope
Main	8.10	158.35	6871.88	109.55	6920.00	6554.73	365.27	-3%	-3%
L-5	6.69	0.00	537.29	80.29	6687.45	6642.01	45.44	-23%	-3%
L-6	7.63	0.00	964.74	172.27	6700.00	6611.70	88.30	-12%	-3%
L-6 L1	1.47	0.00	349.52	237.33	6660.95	6625.97	34.97	-12%	-6%
L-7	0.24	1.50	116.27	476.90	6615.71	6592.84	22.87	-28%	-6%
L-8	0.92	1.50	261.98	285.25	6590.00	6570.00	20.00	-10%	-3%
R-4	4.35	0.00	371.81	85.38	6,750.00	6,691.57	54.43	-16%	-6%
R-5	4.19	0.00	668.09	159.60	6,760.77	6,674.18	86.80	-33%	-3%
R-6	2.03	0.85	337.09	166.23	6689.14	6658.76	30.38	-12%	-3%
R-7	2.09	5.60	524.45	250.51	6675.30	6651.58	23.72	-9%	-3%
R-8	2.53	2.28	640.43	253.49	6691.95	6636.40	55.55	-12%	-3%
R-9	2.25	0.25	605.34	414.56	6666.88	6620.11	46.77	-10%	-3%
R-9 R1	0.33	1.64	187.02	559.99	6647.02	6629.06	17.96	-10%	-6%
R-9 R2	0.22	2.18	142.29	632.61	6642.73	6625.48	17.25	-12%	-10%
R-10	0.55	1.65	248.45	452.47	6634.25	6618.27	15.98	-10%	-3%
R-11	0.27	3.02	108.23	406.35	6609.46	6593.25	16.21	-17%	-3%
R-12	0.13	15.00	152.42	1142.16	6594.57	6581.83	12.74	-8%	-7%
TOTAL	**43.99**	**193.82**							

Table 3.2 Reliance No. 3: Main Basin Runoff Parameters

Basin Name	*Bank-full Conditions**				*Flood-prone Conditions***			
	width range (ft.)	**depth range (ft.)**	**Shields shear stress, (psf)**	**Qpk (cfs)**	**width range (ft.)**	**depth range (ft.)**	**Shields shear stress, (psf)**	**Qpk (cfs)**
Main	11.40 to	0.74 to 1.02	1.03 to 1.61	74.08	22.40 to	2.20 to 3.04	2.58 to 3.00	277.80
L-5	0.40 to 2.46	0.07 to 0.20	0.29 to 0.58	2.24	0.89 to 5.46	0.09 to 0.57	0.49 to 0.88	8.40
L-6	0.22 to 2.65	0.02 to 0.21	0.18 to 0.86	2.55	0.53 to 5.87	0.06 to 0.64	0.27 to 1.31	9.58
L-6 L1	0.38 to 1.05	0.04 to 0.10	0.26 to 0.46	0.49	0.93 to 2.57	0.11 to 0.30	.40 to 0.69	1.85
L7	1.06 to 1.27	0.11 to 0.10	0.22 to 2.08	0.58	2.60 to 2.81	0.27 to 0.32	.36 to 3.17	2.19
L-8	1.06 to 1.49	0.11 to 0.12	0.19 to 0.72	0.81	2.61 to 3.31	0.28 to 0.37	0.32 to 1.09	3.04
R-4	0.24 to 1.98	0.02 to 0.16	0.22 to 1.43	1.46	0.58 to 4.42	0.07 to 0.51	0.37 to 2.17	5.47
R-5	0.20 to 1.96	0.02 to 0.16	0.29 to 0.79	1.40	0.50 to 4.34	0.06 to 0.48	0.48 to 1.20	5.25
R-6	0.89 to 1.62	0.09 to 0.13	0.24 to 0.75	0.96	2.18 to 3.59	0.23 to 0.40	0.40 to 1.13	3.61
R-7	2.07 to 2.66	0.21 to 0.21	0.36 to 0.87	2.58	5.08 to 5.91	0.54 to 0.62	0.61 to 1.33	9.66
R-8	1.36 to 2.11	0.14 to 0.17	-0.54 to 1.18	1.62	3.33 to 4.68	0.35 to 0.53	-0.90 to 1.79	6.06
R-9	1.14 to 2.41	0.11 to 0.19	0.33 to 0.80	2.11	2.81 to 5.36	0.29 to 0.60	0.56 to 1.21	7.91
R-9 R1	1.28 to 1.37	0.13 to 0.14	0.60 to 0.91	0.85	3.15 to 3.37	0.36 to 0.39	0.91 to 1.39	3.18
R-9 R2	0.46 to 0.59	0.05 to 0.06	0.32 to 0.45	0.16	1.13 to 1.46	0.13 to 0.17	0.49 to 0.69	0.60
R-10	1.11 to 1.42	0.11 to 0.11	0.19 to 0.76	0.74	2.74 to 3.16	0.29 to 0.34	0.32 to 1.16	2.76
R-11	1.06 to 1.27	0.11 to 0.10	0.20 to 1.03	0.59	2.60 to 2.83	0.27 to 0.32	0.34 to 1.57	0.59
R-12	3.34 to 3.75	0.33 to 0.30	0.73 to 1.97	5.07	8.22 to 8.32	0.87 to 0.95	1.23 to 2.99	19.00

Table 3.3 Reliance No. 3: Valley 2 Physical Properties

Basin Name	Actual Watershed Area (ac.)	Actual Addn'l Watershed area (Ac.	valley length (ft.)	drainage density (ft./ac.)	head elev (ft.)	base elev (ft.)	total relief (ft.)	head slope	base slope
Main	10.17	87.50	4524.12	102.19	6852.15	6554.72	297.44	-4%	-3%
L-3	0.53	0.85	189.90	357.56	6633.07	6604.44	28.64	-16%	-14%
L-4	0.20	10.80	100.22	513.31	6615.01	6597.30	17.70	-23%	-22%
L-5	0.33	1.50	175.39	531.52	6610.37	6585.64	24.73	-12%	-8%
L-6	0.42	2.60	214.53	510.41	6604.52	6577.78	26.73	-13%	-9%
L-7	0.33	5.80	171.35	515.24	6580.60	6561.65	18.95	-10%	-3%
R-3	2.88	0.00	384.29	133.53	6660.24	6618.62	41.62	-13%	-6%
R-4	0.34	1.60	110.82	325.07	6619.34	6606.83	12.50	-17%	-22%
R-5	0.28	1.30	121.77	437.98	6606.30	6591.68	14.61	-15%	-6%
R-6	0.96	0.75	276.75	287.40	6610.00	6581.50	28.50	-18%	-3%
TOTAL	**16.44**	**112.70**							

Table 3.4 Reliance No. 3: Valley Two Runoff Parameters

Basin Name	*Bank-full Conditions**				*Flood-prone Conditions***			
	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)
Main	9.74 to 11.79	0.61 to 0.75	1.22 to 0.92	39.36	19.55 to	1.85 to 2.21	2.59 to 2.27	147.59
L-3	0.83 to 1.12	0.08 to 0.09	0.41 to 0.97	0.46	2.04 to 2.50	0.22 to 0.29	0.70 to 1.47	1.73
L-4	0.25 to 0.43	0.02 to 0.03	0.38 to 0.62	0.07	0.61 to 0.97	0.07 to 0.11	0.59 to 0.94	0.26
L-5	1.06 to 1.30	0.11 to 0.10	0.29 to 0.92	0.61	2.60 to 2.88	0.27 to 0.33	0.49 to 1.39	2.30
L-6	1.41 to 1.67	0.14 to 0.13	0.46 to 1.39	1.01	3.47 to 3.71	0.37 to 0.42	0.78 to 2.11	3.79
L-7	2.08 to 2.38	0.21 to 0.19	0.39 to 1.39	2.05	5.11 to 5.29	0.54 to 0.60	0.65 to 2.12	7.70
R-3	0.42 to 1.61	0.04 to 0.13	0.26 to 0.78	0.96	1.03 to 3.59	0.11 to 0.41	0.43 to 1.19	3.61
R-4	1.14 to 1.33	0.11 to 0.11	0.27 to 1.33	0.65	2.79 to 2.96	0.29 to 0.34	0.45 to 2.02	2.44
R-5	0.99 to 1.20	0.10 to 0.10	0.21 to 0.87	0.53	2.42 to 2.67	0.26 to 0.31	0.36 to 1.32	1.98
R-6	1.41 to 1.81	0.14 to 0.14	0.28 to 1.49	1.19	3.46 to 4.02	0.37 to 0.46	0.47 to 2.26	4.47

Table 3.5 Reliance No. 3: Outlet Channel Physical Properties

Basin Name	watershed area (ac.)	addn'l watershed area (ac.)	valley length (ft.)	drainage density (ft./ac.)	head elev (ft.)	base elev (ft.)	total relief (ft.)	head slope	base slope
Main	5.32	447.36	1407.00	47.57	6551.50	6512.00	39.50	-2%	-2%
TOTAL	**5.32**	**447.36**							

Table 3.6 Reliance No. 3: Outlet Channel Runoff Parameters

Basin Name	*Bank-full Conditions**				*Flood-prone Conditions***			
	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)
Main	18.06 to	1.52 to 1.69	1.38 to 2.18	154.19	40.32 to	4.39 to 4.88	3.42 to 3.89	578.21

Table 3.7 Reliance No. 3: North Pit Physical Properties

Basin Name	watershed area (ac.)	Addn'l Watershed area (Ac.	valley length (ft.)	drainage density (ft./ac.)	head elev (ft.)	base elev (ft.)	total relief (ft.)	head slope	base slope
Main	3.69	1.43	588.28	159.24	6778.67	6740.00	38.67	-11%	-5%
R-1	1.75	1.55	312.46	178.23	6785.95	6748.26	37.69	-12%	-7%
TOTAL	**5.45**	**2.98**							

Table 3.8 Reliance No. 3: North Pit Runoff Parameters

Basin Name	*Bank-full Conditions**				*Flood-prone Conditions***			
	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)
Main	0.10 to 2.12	0.01 to 0.21	0.07 to 0.75	2.03	0.25 to 5.22	0.03 to 0.60	0.10 to 1.14	7.61
R-1	0.21 to 1.18	0.02 to 0.12	0.17 to 0.71	0.63	0.51 to 2.91	0.06 to 0.33	0.26 to 1.07	2.36

Table 3.9 Reliance No. 3: North Spoils Physical Properties

Basin Name	watershed area (ac.)	addn'l watershed area (ac.)	valley length (ft.)	drainage density (ft./ac.)	head elev (ft.)	base elev (ft.)	total relief (ft.)	head slope	base slope
Main	4.50	12.90	483.98	107.45	6698.00	6644.49	53.51	-10%	-7%
TOTAL	**4.50**	**12.90**							

Table 3.10 Reliance No. 3: North Spoils Runoff Parameters

Basin Name	*Bank-full Conditions**				*Flood-prone Conditions***			
	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)	width range (ft.)	depth range (ft.)	Shields shear stress, (psf)	Qpk (cfs)
Main	3.10 to 3.60	0.31 to 0.36	1.68 to 2.34	5.83	7.62 to 8.84	0.88 to 1.02	2.56 to 3.56	21.85

Table 3.11 Reliance No. 3: USA-COE Steep Slope Riprap Design

Structure ID	Peak Flow In (cfs)	Bottom Width (feet)*	Unit Discharge (sf/s)**	Grade (ft/ft)	D30 Rock (feet)	D50 Rock (feet)	D50 Rock (inch)	D50 SPEC'D (inch)
DROP 1	576	12	60.0	0.1429	3.20	3.00	36.0	36
DROP 2	29.9	12	3.1	0.1667	0.49	0.50	6.0	6
DROP 3	8.75	5	2.2	0.25	0.48	0.50	6.0	6
GC-1	7.33	10	0.9	0.2	0.24	0.35	4.2	6
GC-2	172.3	5	43.1	0.0289	1.06	1.00	12.0	15
GC-3	306.3	6.5	58.9	0.0261	1.23	1.30	15.6	15
GC-4	425.4	7	76.0	0.0251	1.43	1.50	18.0	15
GC-5	120.1	12	12.5	0.154	1.17	1.20	14.4	15

*Assume Bw of V-ditches is 2' due to construction practices

**Multiplied by C=1.25

Table 3.12 Reliance No. 3: Rock Structure Summary

Drop Structure ID	Peak Flow IN (cfs)	Bottom Width (feet)*	Length (feet)	Grade (ft/ft)	Depth (feet)	Side Slope h:v	Apron Length (feet)	Riprap Class (inch)	Riprap Depth (inch)	Riprap Quantity (cy)*	Bedding Quantity (cy)*	Fabric Quantity (sf)*
DROP 1	576	12	63	0.1429	4	3	12	36	54	574	64	5830
DROP 2	29.9	12	60	0.1667	3	3	10	6	12	98	49	3864
DROP 3	8.75	5	18	0.25	3	3	7	6	12	28	15	1523

Grade Control ID	Peak Flow IN (cfs)	Bottom Width (feet)*	Length (feet)	Grade (ft/ft)	Depth (feet)	Side Slope h:v	Riprap Class (inch)	Riprap Depth (inch)	Riprap Quantity (cy)*	Bedding Quantity (cy)*	Fabric Quantity (sf)*
GC-1	7.33	10	15	0.2	3	3	6	12	17	9	1080
GC-2	172.3	5	10	0.0289	3	4	15	30	30	6	1100
GC-3	306.3	6.5	10	0.0261	3	4	15	30	31	6	1138
GC-4	425.4	7	10	0.0251	3	4	15	30	32	6	1150
GC-5	120.1	12	20	0.154	3	3	15	30	61	12	1575

*10% factor added

3.3 Lionkol Main Pit: Hydrologic Features Summary

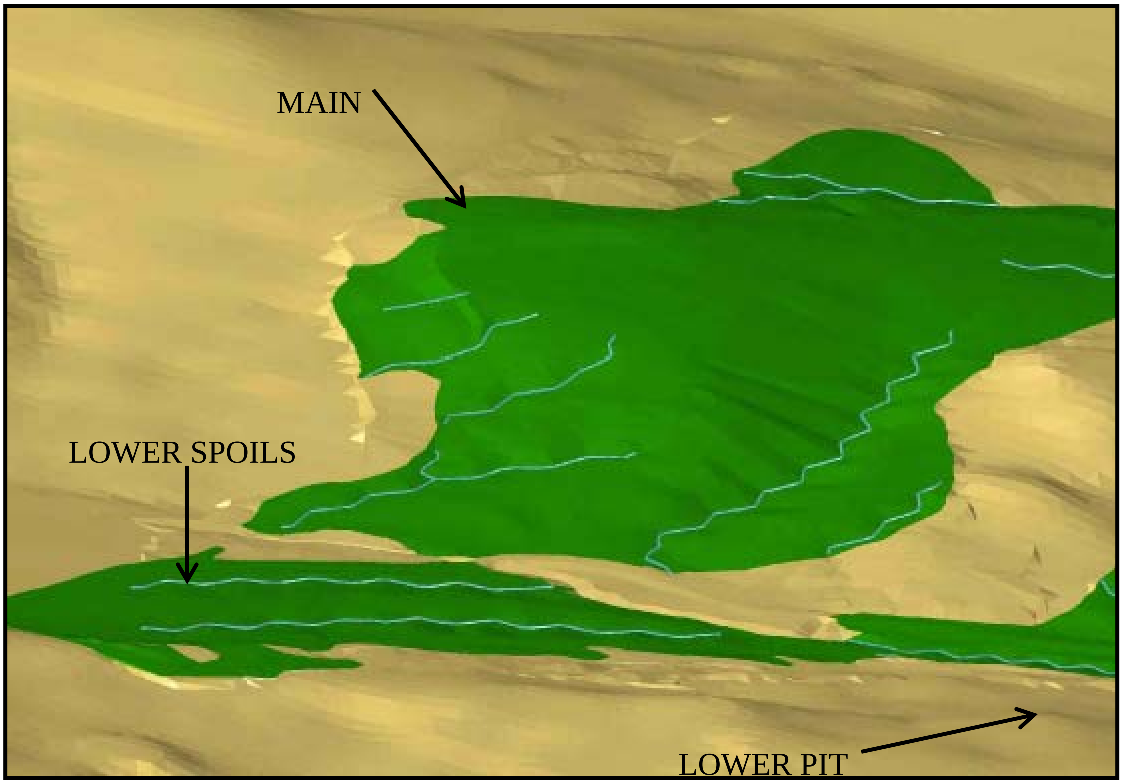


Figure 18: Lionkol Pit Design 3-Dimensional Rendering (not including Lower Pit)

3.3.1 Lionkol Main Pit: Geomorphic Channels

Three separate areas were reclaimed as part the Lionkol Pit reclamation portion of the 17H-2B-II project: the Main Pit, the Lower Pit, and the Lower Spoils. Thirteen separate NR basins were modeled for the area designs as shown in Figure A-3.7 in Appendix A3.3. The Main Pit design is a composite of 10 separate NR designs as it is characterized by multiple upland channels which drain off-site. The Lower Pit was modeled as a single basin with two tributaries. The Lower Spoils design is a composite of two separate NR models for two separate channels draining into the Lionkol Drainage. The hydrologic parameters of each of these areas are described in subsequent sections.

The properties of the Lionkol Main Pit basins are shown in Tables 3.13 and 3.14 in Appendix B3.3. The Lionkol Main Pit area was a “mountain top strip” type of open pit with over-steepened spoils pushed off both the north and south ends of the pit which was located at the top of the ridge. The reclamation design for this area was modeled as 10 distinct basins due to the uplands nature of the site, without any connecting channels. The Main Pit has a total acreage of approximately 54 acres, so the average uplands basin designed for this project was small, averaging 5.4 acres per channel. While each basin was essentially a separate project, they have been combined into a single table for physical and hydrologic parameters provided in Table 3.13. For this project, the overall design attempted to reclaim the site to approximate pre-mine contours by removing the spoils that had been dozed off the top of the ridge, and relocate them up in the pit. During the excavation of the spoils, the pre-mine surface was exhumed on both the north and south sides, exposing native sandstone rock outcrops. As a result, the channels South 2, Northeast 1, and Northeast 2 were not built to the design grades over portions of their alignment, but rather had steep sections of sandstone rock, with the design grades constructed above and below the bedrock sections. Note that most of the channel shear ranges are in excess of Carlson software's recommended stability criteria for shear. For these basins, the high shears are primarily related to steep channel gradients. However, based upon the small average basin size, the total volume of flow is typically low, and as such the ability of the flows to do much erosive work is minimal. Performance to date on site indicates that many of the basins are stable as discussed in Section 3.3.4, although the calculations indicated potential erosion. An exception is the Lionkol North Main channel, which has a larger watershed area and was exhibiting visible erosion. Repairs were made as described below, and as bedrock material is being exposed in the flow-line for this channel, so it is believed that further degradation is unlikely to occur. Due to the volume of data, detailed data for Shields shear values by station are not included in this report but are available upon request.

The design properties of the Lionkol Lower Pit area are shown in Tables 3.15 and 3.16 below. The Lionkol Lower Pit was backfilled with material from the Lionkol Lower Spoils, creating a single basin draining to a small sediment pond prior to passing under the Lionkol road through a 24" culvert installed by the project, where it drains into the Lionkol drainage reclaimed under AML 17H-2B-III. The Lionkol Lower Pit has a total acreage of approximately 5 acres. The basin length is approximately 700' with total vertical relief of approximately 48'. As a result, the channel gradients for the Main channel and its two tributaries are 6% at the flattest, and increase from there up to a maximum of 18% grades. Note that the shear ranges for the channels are in excess of Carlson software's recommended stability criteria for shear, with the Main channel characterized by a Flood-prone maximum shear of 5.28 psf; the highest shear noted on any of the project sites for this project. For these basins, the high shears are primarily related to steep channel gradients. However, based upon the small average basin size, the total volume of flow is typically low, and as such the ability of the flows to do much erosive work is minimal. Performance to date on site indicates that many of the basins are stable as discussed in Section 3.3.4.

The properties of the Lionkol Lower Spoils design are shown in Tables 3.17 and 3.18 below. The Lionkol Lower Spoils were excavated to approximate pre-mine contours and shaped into two separate basins draining into the Lionkol Drainage reclaimed under AML 17H-2B-III. The Lionkol Lower Spoils has a total acreage of approximately 12 acres divided between the two basins. The basin lengths range from approximately 780' up to 1180' with total vertical relief of approximately 42' and 74' respectively. As a result, the channel gradients for the two long upland basins are 6% at the flattest, and increase from there up to a maximum of 8% grades on the main channels. Note that the shear ranges for the channels meet Carlson software's recommended stability criteria for shear. While the channel gradients are moderately steep, combined with the small average basin size the total volume of flow is low and as such the potential for erosion is minimal. Performance to date on site indicates that the basins are stable as discussed in Section 3.3.4.

3.3.2 Lionkol Lower Pit: Impoundment

The Lionkol Lower Pit Pond as shown on Figure A-3.9 in Appendix A3.3 was designed to create a small surface water impoundment and to minimize the peak flows from the Lower Pit area into the Lionkol Drainage, which at the time of the project was in an un-reclaimed, highly eroded state and it was not scheduled for reclamation at the time. As such it was thought that rather than impound all off-site flow from the Lionkol Lower Pit as had been previously done on the Reliance No. 11 Pits, a smaller impoundment to minimize the peak flows would be utilized. A 100' – 24" CMP culvert was installed under the Lionkol Road to drain the impoundment to the Lionkol Drainage, providing a storage capacity of 1.4 acre-feet as shown in Table 3.19.

For the Lionkol Lower Pond, a total discharge of 2.1 acre-feet was estimated for the 100-year, 24-hour event, exceeding the 1.4 acre-feet capacity of the pond. Total attenuation time was not estimated for the relatively low discharge quantity anticipated from this impoundment.

3.3.3 Lionkol Main Pits: Riprap Structures

The United States Army Corps of Engineers Steep Slope Riprap Design Method was utilized for the sizing of the riprap to be utilized in the Lionkol drop structures. This is a conservative method which over-sizes the rock with multiple safety factors built into the formulas. Design peak discharges were based upon the TR-55 method for estimating discharges utilizing ACAD Land Desktop's hydrology module. A 100-year, 24-hour storm event was employed for estimation of peak flows for the riprap structures.

A drop structure, Drop 3, was constructed where the Lionkol Lower Spoils East Main discharges into the Lionkol Drainage to prevent the East Main channel from being constructed overly steep and to minimize total earthwork from the Lionkol Lower Spoils. Drop 3 was constructed of class 6 riprap from the Pete Lien quarry near Rawlins, WY. The dimensions and quantities of the outlet structures are shown in Table 3.20 and Table 3.21.

3.3.4 Lionkol Main Pits: Performance Evaluation

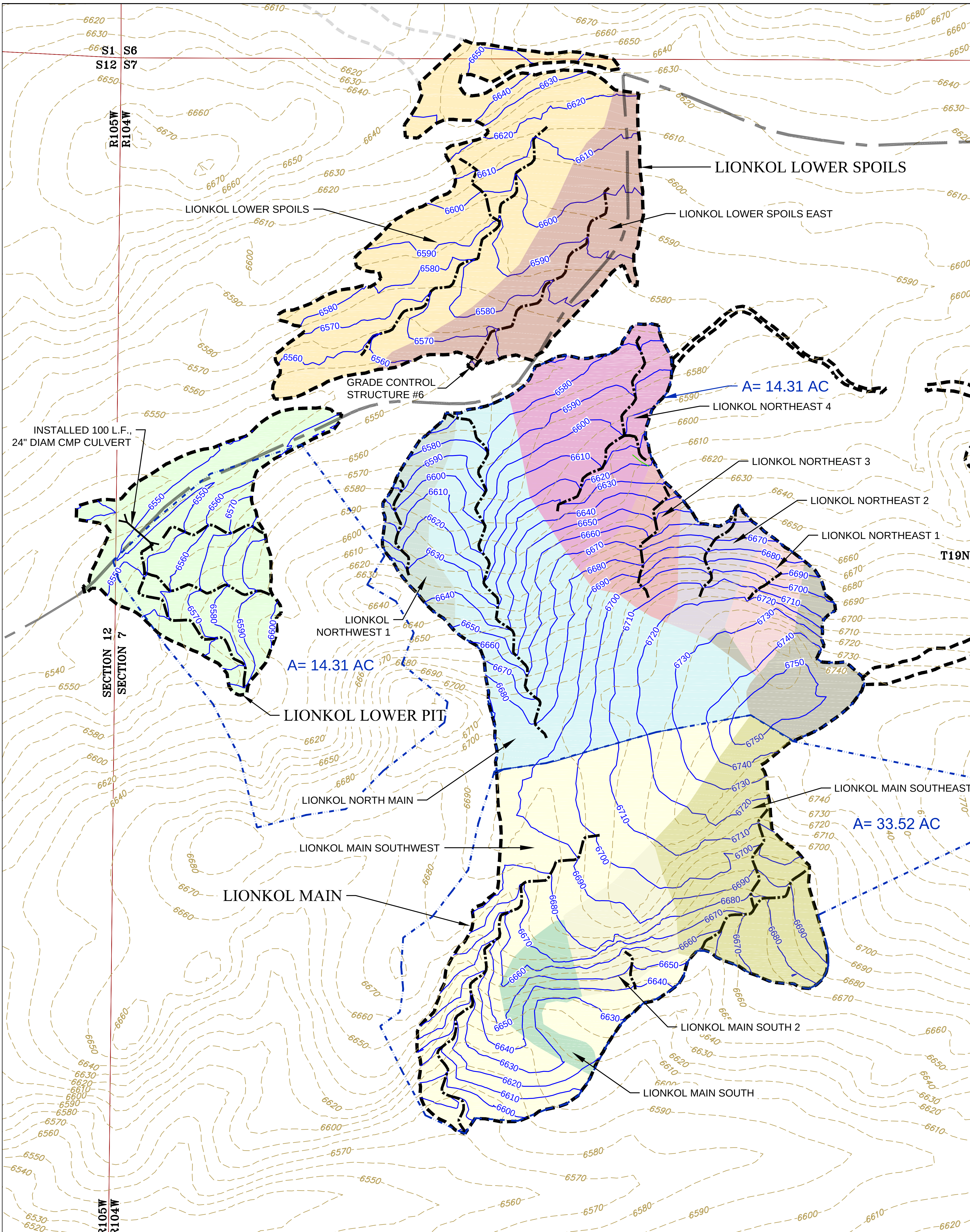
A field inspection of the channels on the Lionkol Pits area was completed in August of 2013. The site was re-vegetated in the fall of 2009, providing four full growing seasons for re-vegetation to occur. However, compared to the other reclaimed areas the Lionkol Pits were very poorly re-vegetated, and it is expected that runoff quantities will be high with little attenuation due to low vegetation.

Performance of channels in the Lionkol Main area was mixed. As mentioned in Section 3.3.1, the geomorphic channels constructed for the Lionkol Pit basins all had high head and base grades (many over 20% and none below 6%). However, the contributing basins of most channels are also generally small (< 6 acres) and the low area of the basins generally results in lower runoff volumes. As such, stable channels would result even at higher gradients. The relatively low Shields shear stresses modeled by NR supports that conclusion. Poor performance of a few of the channels within the largest basins in the Main Pit area also supports that hypothesis. Failures occurred on the North Main drainage, the Northwest Main, and the Northeast 4 Main and R1 drainages (see as-built drawings in Figures A-3.12 and A-3.13 of Appendix A3.3), requiring repair. Smaller basins like the Lower Pit and Lionkol South Main were areas where the channels were found to have performed well and behaved similarly to geomorphic channels in Reliance No.11 North (see Section 2.2.6 for successful geomorphic channel summary).

Failures within the Northwest 1 and Northeast 4 channels were less than 100 feet in length and between 12 and 18 inches in depth, requiring simple reinforcement repairs with a dozer and/or a scraper. The North Main channel had become completely incised exposing bedrock between 18 and 36 inches in depth by October of 2013. Although the channel was hard-pointing on bedrock, and would eventually have corrected itself, the process would have required many years and would have resulted in unacceptable amounts of sediment being transported downstream. As a result, the channel was widened utilizing an excavator, maintaining the incised flow-line elevation for the entirety of its length. The increase in cross sectional flow area is expected to drop the flow energy within the channel and prevent unacceptable levels of continued erosion. In addition, the ditch on the south side of the road into which the channel drained was reinforced with the excavator.

Figure 19: Lionkol North Main: Channel failure incised to bedrock

The erosion of the North Main channel resulted from several factors. In addition to having high gradients and the largest basin area in excess of 13 acres, the west facing slope of the North Main channel had the poorest re-vegetative success covering a widespread area of any Lionkol reclamation area. The lack of vegetation and lack of infiltration of rainwater into the poor soil of the slope increased runoff and caused unacceptable erosion within the main drainage. To mitigate this problem, multiple hummocks and swales were constructed on the slope utilizing a dozer to trap runoff, promote moisture retention and future vegetative growth.



LEGEND

(red line)	SECTION LINES	(symbol)	CONSTRUCTED MEANDER CHANNEL
(grey dashed line)	ROAD	(symbol)	CONSTRUCTED "A" CHANNEL
(black dashed line)	RECLAMED AREAS	(blue dash-dot line)	DRAINAGE BASIN BOUNDARY
6400	EXISTING GROUND CONTOURS C.I.-10'	A= 1.48	DRAINAGE BASIN AREA
6400	ASBUILT CONTOURS C.I.-10'		

300' 0 150' 300'
1 inch = 300 ft

LIONKOL OVERALL MAP

SCALE: 1" = 300'
DRAWN BY: CDS
CHECKED: HH
APPROVED: HH
DATE 3/24/14
DWG. NO. FIGURE A-3.7
REV.

NATURAL REGRADE RECLAMATION PROJECTS
AML PROJECT 17 H-2
SWEETWATER COUNTY WYOMING

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

LAST PLOT DATE: 3/24/14
CAD FILENAME: DATA/17H/NATURAL REGRADE PROJECTS/FIG A-3.7 Lionkol Base Map.dwg

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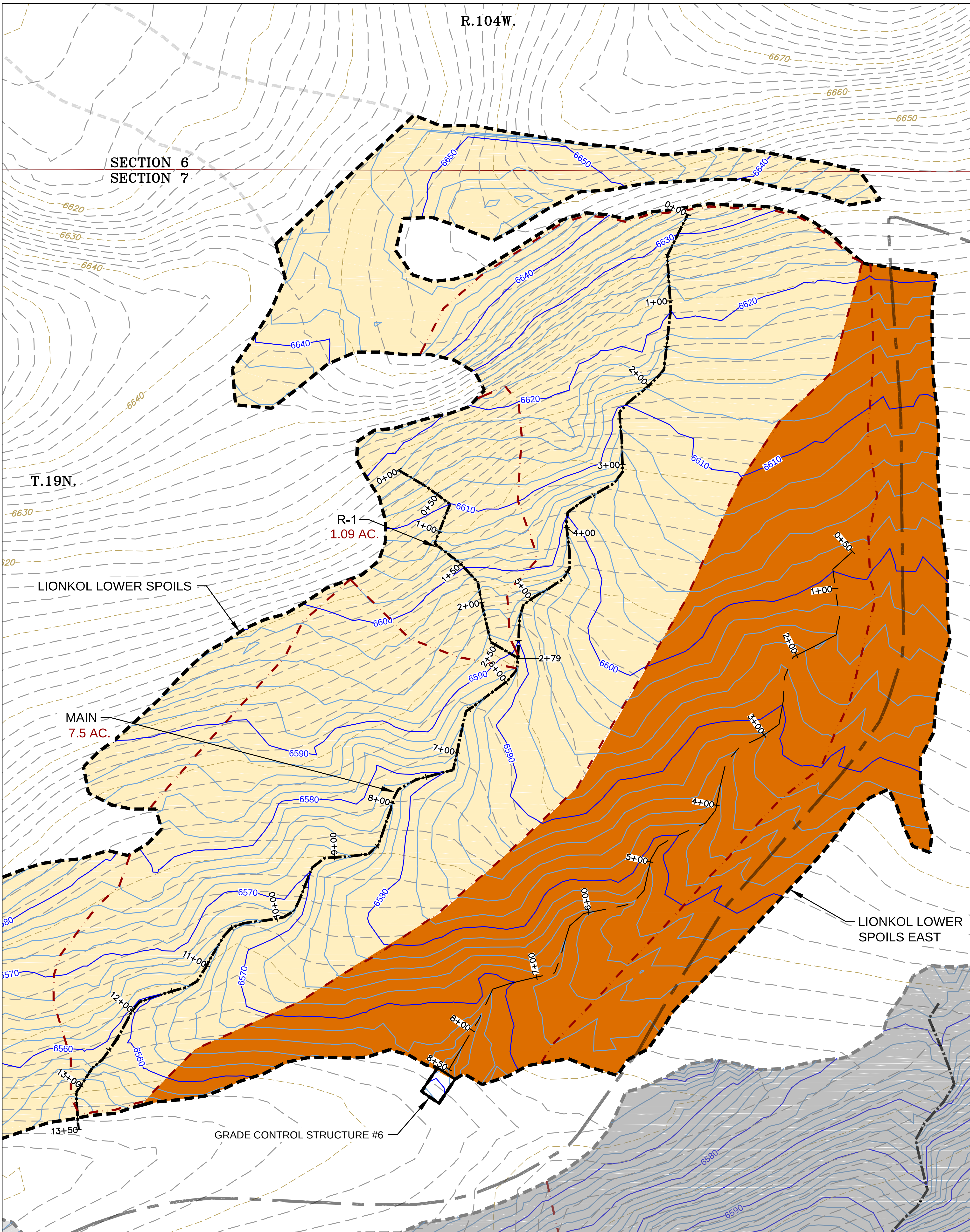


LEGEND

	SECTION LINES	A=1.48 AC	DRAINAGE BASIN AREA
	ROAD	A=1.48 AC	CONTRIBUTING SUB-BASIN AREA
	RECLAIMED AREAS	A=1.48 AC	CONSTRUCTED SUB-BASIN AREA
6400	EXISTING GROUND CONTOURS C.I.-10'		DRAINAGE BASIN BOUNDARY
6400	ASBUILT CONTOURS C.I.-2'		SUB-BASIN BOUNDARY
	CONSTRUCTED MEANDER CHANNEL		CONSTRUCTED SUB-BASIN BOUNDARY
	CONSTRUCTED "A" CHANNEL		

0+00 0+100 CHANNEL STATIONING

100' 0 50' 100'

1 inch = 100 ft

LOWER LIONKOL SPOILS

SCALE: 1" = 100' DATE 3/25/14
DRAWN BY: CDS
CHECKED: HH
APPROVED: HH

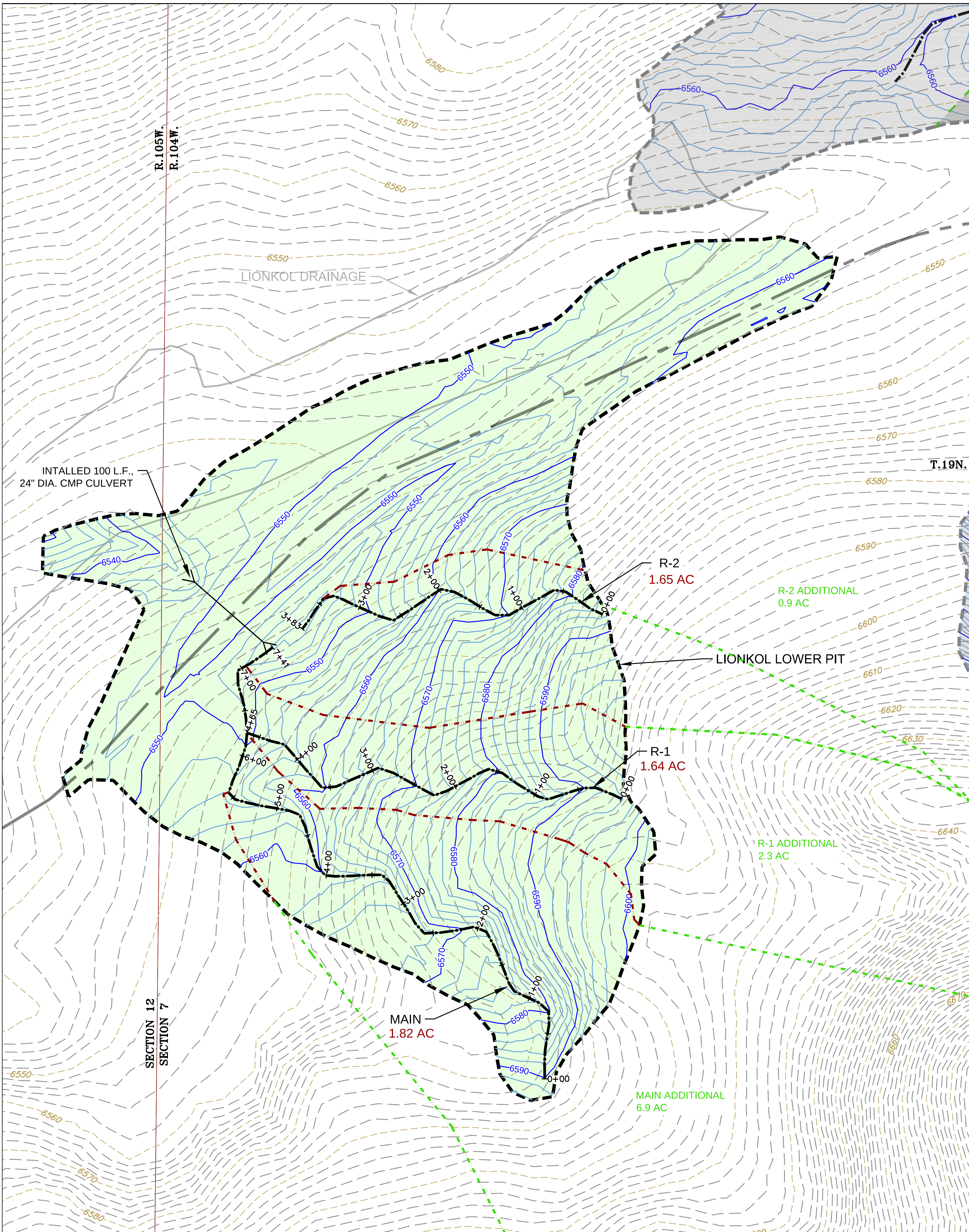
DWG. NO. FIGURE A-3.8 REV.

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

LAST PLOT DATE: 3/25/14
CAD FILENAME: NATURAL REGRADE PROJECTS/LIONKOL MAIN/FIG A-3.8 LOWER LIONKOL SPOILS.dwg

BRS ENGINEERING



LEGEND

SECTION LINES		A=1.48 AC	DRAINAGE BASIN AREA
ROAD		A=1.48 AC	CONTRIBUTING SUB-BASIN AREA
RECLAIMED AREAS		A=1.48 AC	CONSTRUCTED SUB-BASIN AREA
6400	EXISTING GROUND CONTOURS C.I.-10'		DRAINAGE BASIN BOUNDARY
6400	ASBUILT CONTOURS C.I.-2'		SUB-BASIN BOUNDARY
CONSTRUCTED MEANDER CHANNEL			CONSTRUCTED SUB-BASIN BOUNDARY
CONSTRUCTED "A" CHANNEL			

0+00 0+100 CHANNEL STATIONING

100' 0 50' 100'
1 inch = 100 ft

LOWER LIONKOL PIT

SCALE: 1" = 100'
DRAWN BY: CDS
CHECKED: HH
APPROVED: HH
DATE 3/31/14

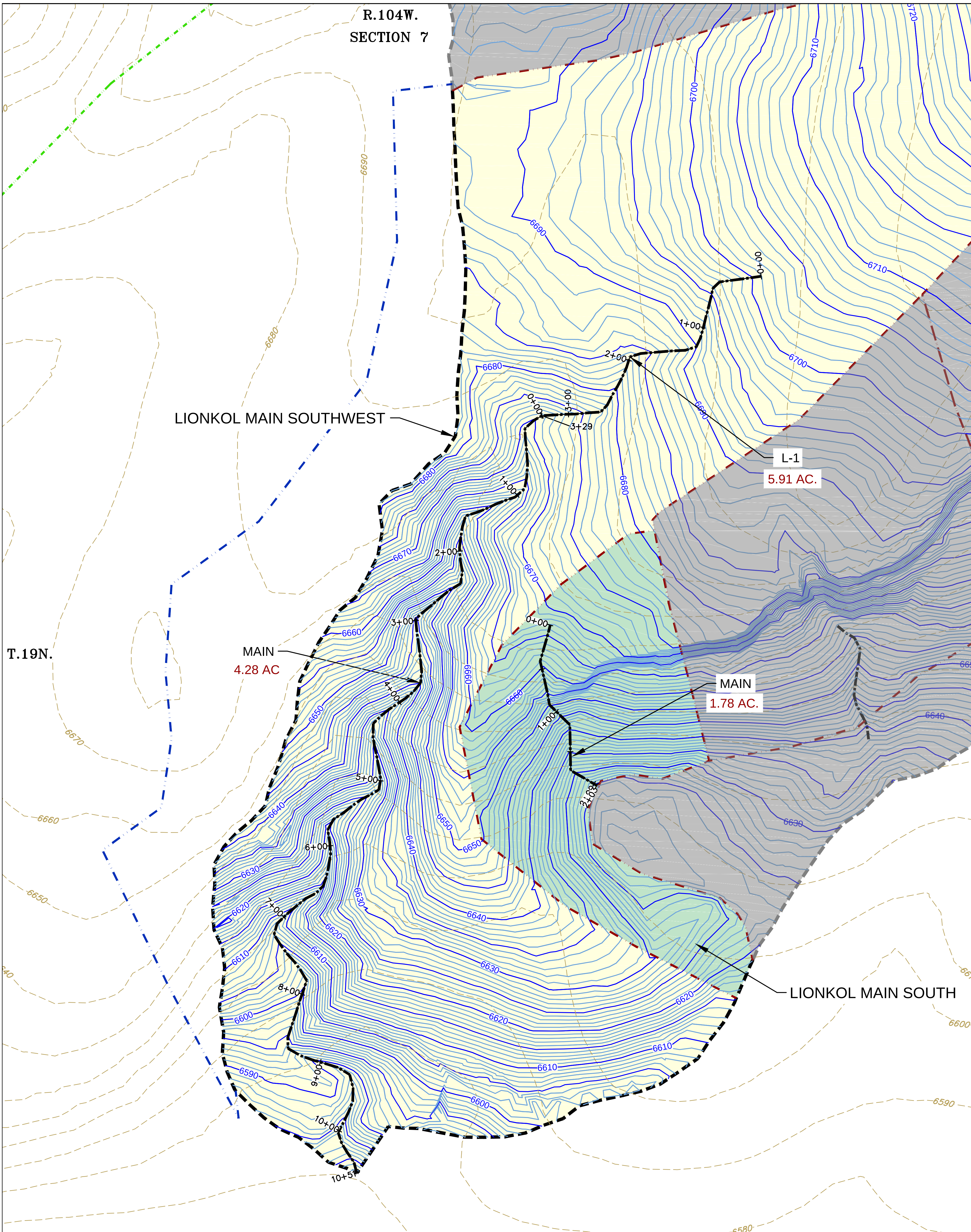
DWG. NO. FIGURE A-3.9
REV.

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

LAST PLOT DATE: 3/31/14
CAD FILENAME: NATURAL REGRADE PROJECTS/LIONKOL MAIN/FIG A-3.9 Lower Lionkol Pit.dwg

BRS ENGINEERING



LEGEND

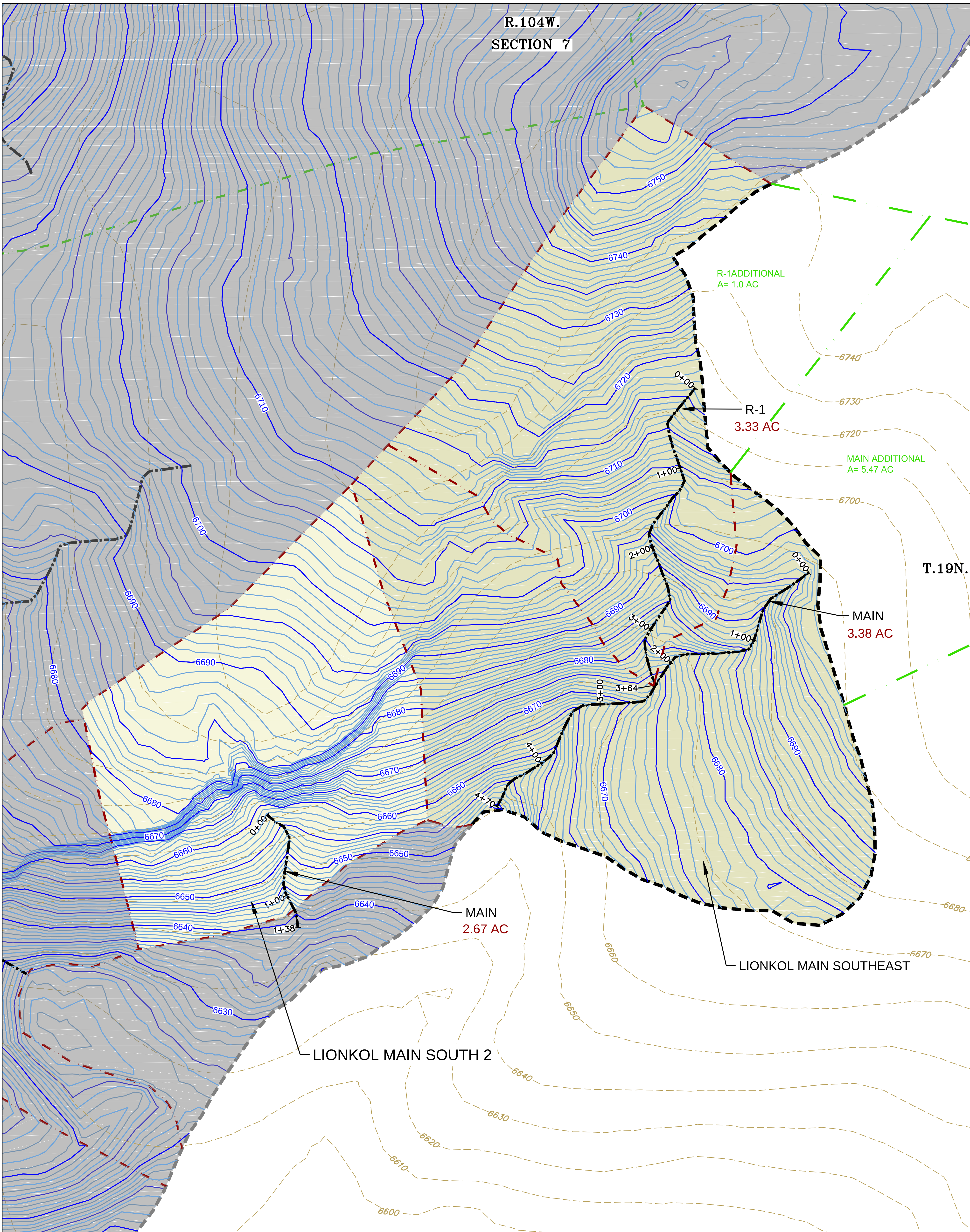
SECTION LINES	CONSTRUCTED MEANDER CHANNEL
ROAD	CONSTRUCTED "A" CHANNEL
RECLAIMED AREAS	CONSTRUCTED DRAINAGE BASIN AREA
6400 EXISTING GROUND CONTOURS C.I.-10'	EXISTING CONTRIBUTING DRAINAGE BASIN AREA
6400 ASBUILT CONTOURS C.I.-2'	0+00 1+00 CHANNEL STATIONING
A=1.48 AC SUB DRAINAGE ACREAGE	
A=1.48 AC CONSTRUCTION DRAINAGE ACREAGE	

N

100' 0 50' 100'

1 inch = 100 ft

LIONKOL MAIN SOUTHWEST & SOUTH		NATURAL REGRADE RECLAMATION PROJECTS AML PROJECT 17 H-2 SWEETWATER COUNTY WYOMING	NO.	REVISION DATE:	DATE	BY	ISSUED FOR
SCALE: 1" = 100' DATE 3/25/14 DRAWN BY: CDS CHECKED: HH APPROVED: HH	DWG. NO. FIGURE A-3.10 REV.		LAST PLOT DATE: 3/25/14 CAD FILENAME: DATA/17H/NATURAL REGRADE PROJECTS/LIONKOL MAIN/COMBINED 4.dwg				BRS ENGINEERING



LEGEND

	SECTION LINES	A=1.48 AC	DRAINAGE BASIN AREA
	ROAD	A=1.48 AC	CONTRIBUTING SUB-BASIN AREA
	RECLAIMED AREAS	A=1.48 AC	CONSTRUCTED SUB-BASIN AREA
6400	EXISTING GROUND CONTOURS C.I.-10'		DRAINAGE BASIN BOUNDARY
6400	ASBUILT CONTOURS C.I.-2'		SUB-BASIN BOUNDARY
	CONSTRUCTED MEANDER CHANNEL		CONSTRUCTED SUB-BASIN BOUNDARY
	CONSTRUCTED "A" CHANNEL		

0+00 0+100 CHANNEL STATIONING

100' 0 50' 100'

1 inch = 100 ft

LIONKIL MAIN SOUTH 2 & SOUTHEAST

SCALE: 1" = 100'
DRAWN BY: CDS
CHECKED: HH
APPROVED: HH
DATE 3/25/14

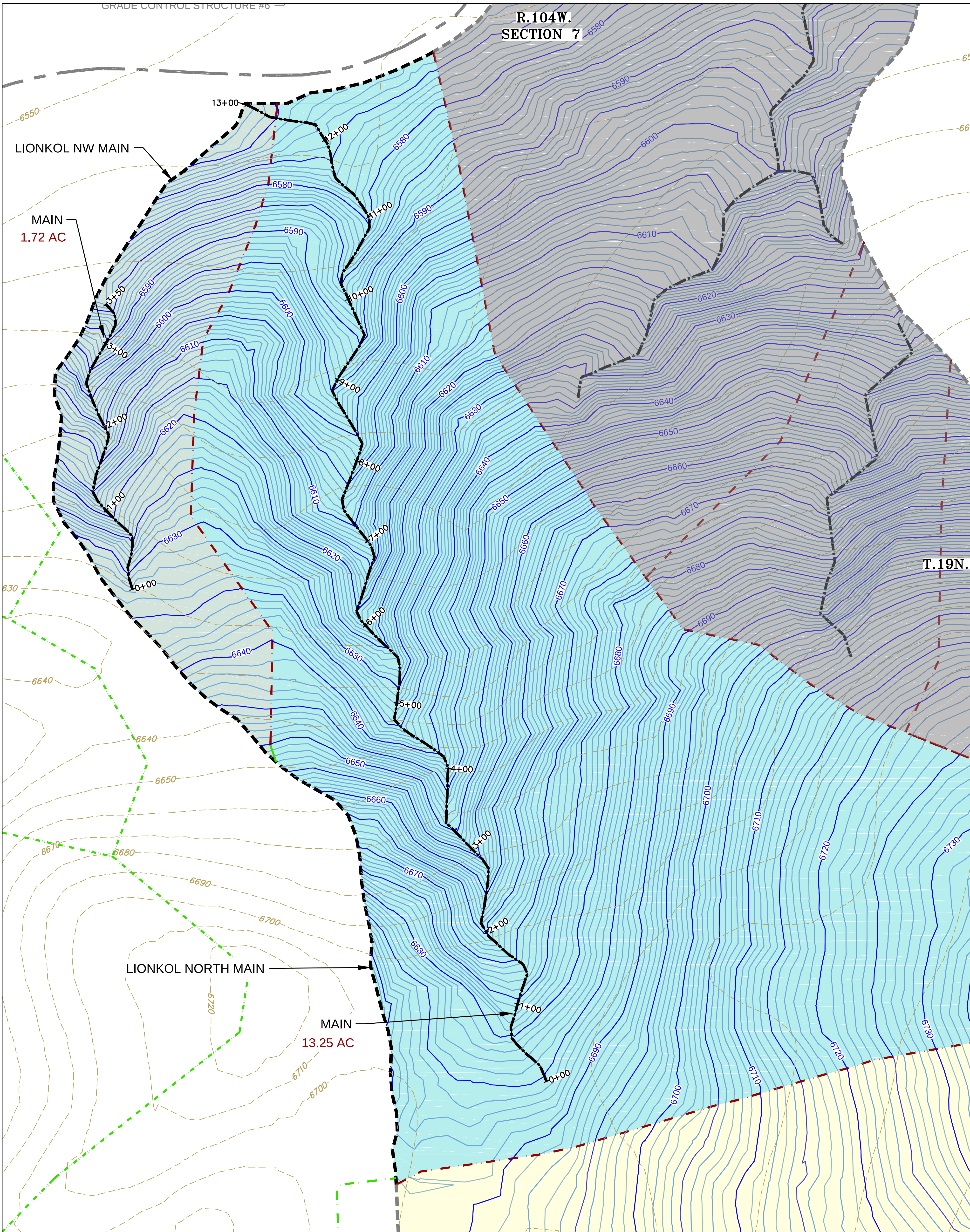
DWG. NO. FIGURE A-3.11 REV.

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

LAST PLOT DATE: 3/25/14
CAD FILENAME: DATA/17H/NATURAL REGRADE PROJECTS/LIONKOL MAIN/COMBINED 5.dwg

BRS ENGINEERING



LEGEND

	SECTION LINES	A=1.48 AC	DRAINAGE BASIN AREA
	ROAD	A=1.48 AC	CONTRIBUTING SUB-BASIN AREA
	RECLAIMED AREAS	A=1.48 AC	CONSTRUCTED SUB-BASIN AREA
6400	EXISTING GROUND CONTOURS C.I.-10'		DRAINAGE BASIN BOUNDARY
6400	ASBUILT CONTOURS C.I.-2'		SUB-BASIN BOUNDARY
	CONSTRUCTED MEANDER CHANNEL		CONSTRUCTED SUB-BASIN BOUNDARY
	CONSTRUCTED "A" CHANNEL		

0+00 0+100 CHANNEL STATIONING

100' 0 50' 100'

1 inch = 100 ft

LIONKOL NORTH & NORTHWEST 1

SCALE: 1" = 100' DATE 3/25/14
DRAWN BY: CDS
CHECKED: HH
APPROVED: HH

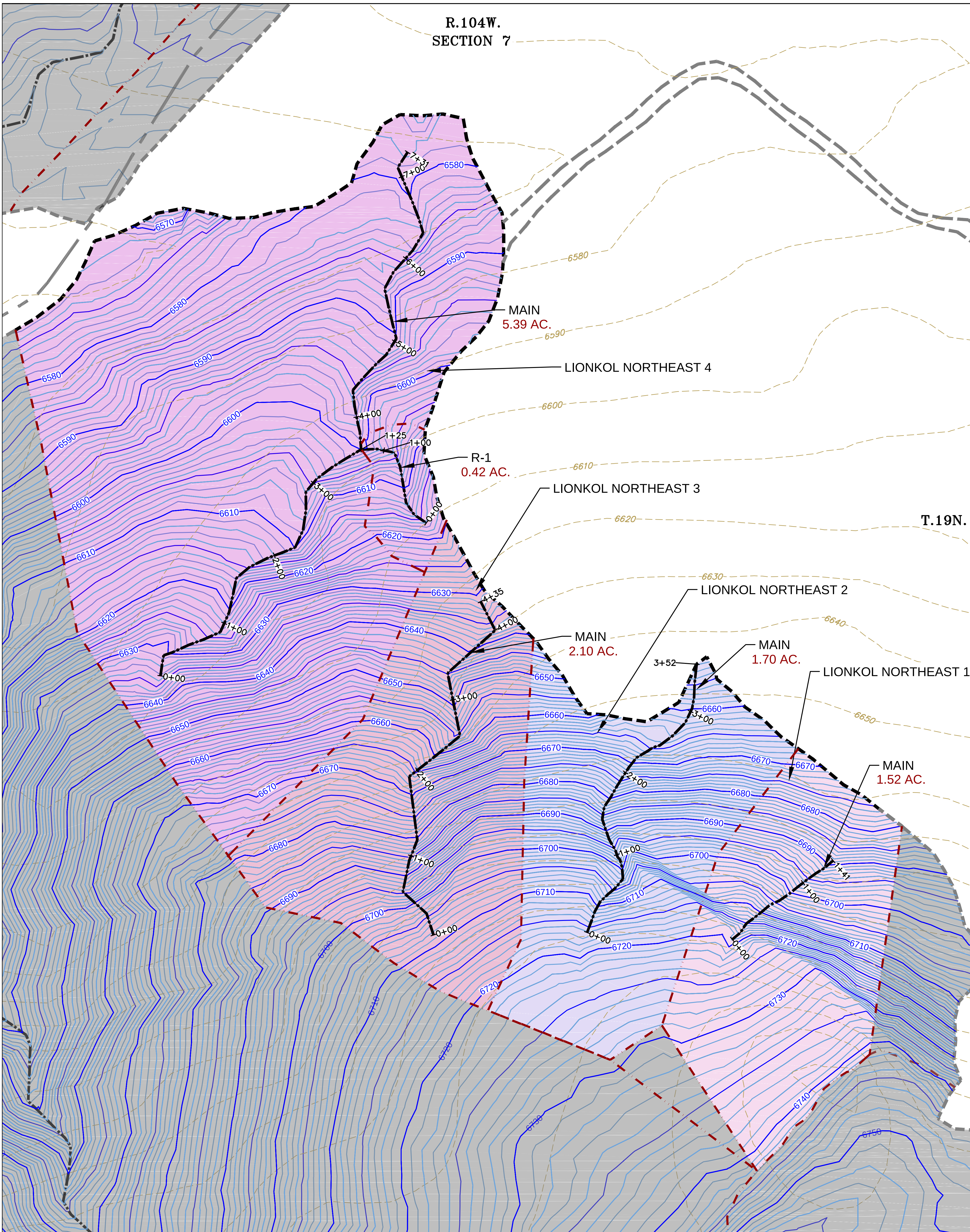
DWG. NO. FIGURE A-3.12 REV.

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

LAST PLOT DATE: 3/25/14
CAD FILENAME: NATURAL REGRADE PROJECTS/LIONKOL MAIN/FIG A-3.12 NORTH AND NW.dwg

BRS ENGINEERING



LEGEND

	SECTION LINES	A=1.48 AC	DRAINAGE BASIN AREA
	ROAD	A=1.48 AC	CONTRIBUTING SUB-BASIN AREA
	RECLAIMED AREAS	A=1.48 AC	CONSTRUCTED SUB-BASIN AREA
6400	EXISTING GROUND CONTOURS C.I.-10'		DRAINAGE BASIN BOUNDARY
6400	ASBUILT CONTOURS C.I.-2'		SUB-BASIN BOUNDARY
	CONSTRUCTED MEANDER CHANNEL		CONSTRUCTED SUB-BASIN BOUNDARY
	CONSTRUCTED "A" CHANNEL		

0+00 0+100 CHANNEL STATIONING

100' 0 50' 100'

1 inch = 100 ft

LIONKOL MAIN NORTHEAST

SCALE: 1" = 100'
DRAWN BY: CDS DATE 3/25/14
CHECKED: HH
APPROVED: HH

DWG. NO. FIGURE A-3.13 REV.

LIONKOL AREA GEOMORPHIC RECLAMATION
AML PROJECT 17 H-2, 2B-II, 2B-III, & 2B-IV
SWEETWATER COUNTY WYOMING

NO.	REVISION DATE:	DATE	BY	ISSUED FOR

LAST PLOT DATE: 3/25/14
CAD FILENAME: NATURAL REGRADE PROJECTS/LIONKOL MAIN/FIG A-3.13 LIONKOL NE.dwg

BRS ENGINEERING