APPENDIX 4-C

SAMPLING AND ANALYSIS PLAN

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Groundwater Pollution Prevention,
Monitoring and Response Action Plan for
Pinedale Anticline Project Area, Sublette County, Wyoming

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1.0 PURPOSE AND SCOPE

NewFields Mining and Energy Services, LLC (NewFields) prepared this Sampling and Analysis Plan (SAP) on behalf of Ultra Resources, Inc. (Ultra) and QEP Energy Company (QEP) for a Groundwater Pollution Prevention, Monitoring and Response Action Plan (Plan) that was developed for the Pinedale Anticline Project Area (PAPA), a natural gas development in Sublette County, Wyoming (**Figure 4C-1**). The Plan (NewFields 2016) complies with a September 2008 Record of Decision (ROD) by the U.S. Department of Interior Bureau of Land Management (BLM) regarding the Supplemental Environmental Impact Statement (SEIS) for the Pinedale Anticline Oil and Gas Exploration and Development Project Area (i.e., PAPA). As part of the 2008 ROD, BLM approved development of the oil and gas resources within the PAPA as outlined in Alternative D of the Final SEIS (BLM 2008a), as modified in the ROD (BLM 2008b). The ROD emphasizes concentrating development, allowing for systematic development, performance based outcomes and adaptive management for reducing impacts, and cooperative monitoring with the State of Wyoming (BLM 2008b).

Besides complying with requirements of BLM's ROD, the Plan also satisfies regulations promulgated by the Wyoming Oil and Gas Conservation Commission (WOGCC). Beginning in March 2014, the WOGCC requires a groundwater baseline sampling, analysis and monitoring plan as part of the Application for Permit to Drill or Deepen a Well (WOGCC 2014; Operational Rules, Drilling Rules; Chapter 3, Section 46). WOGCC Rules allow for a master plan to cover a geographic area of development, and this Plan will serve as the master groundwater baseline sampling, analysis and monitoring plan for the PAPA.

This SAP is based on and adapted from the WOGCC groundwater baseline sampling, analysis, and monitoring program (Appendix K of WOGCC Rules). The SAP provides minimum requirements and protocols that shall be followed by oil and gas operators or their contractors per Chapter 3, Section 46 of the WOGCC Rules. This SAP also follows guidance in DEQ (2013) Fact Sheet #29 (Sampling and Analysis Plans) from the Voluntary Remediation Program (VRP).

The purpose of the SAP is to document field monitoring and sampling procedures, and laboratory methods that will be used to ensure that consistent and representative data are collected, and that a uniform method of data reporting to the agencies and Operators is established. The primary monitoring activities for the PAPA will include: installing and developing new monitoring wells; collecting water samples from existing and new monitoring wells; and measuring water levels in monitoring wells. These activities are components of the Groundwater Monitoring Program (GMP) presented in Section 4.0 of the Plan (NewFields 2016). Data Quality Objectives (DQO) for the GMP are presented in Table 4-1 of the Plan (NewFields 2016).

2.0 BACKGROUND

This section summarizes the 2009-2010 study well installation associated with the Hydrogeologic Data Gaps Investigation (AMEC 2012) and the process used to develop the list of monitoring parameters for this SAP (see Section 4.3 of the Plan [NewFields 2016]).

2.1 STUDY WELL INSTALLATION

BLM's 2008 ROD required Operators in the PAPA to complete additional groundwater characterization. Based on a detailed Plan of Study issued in May 2009, extensive field investigations were completed between 2009 and 2011 to fill identified data gaps. The investigation report (AMEC 2012) describes results of the hydrogeologic data gaps investigation. Thirty study wells ranging in depths from 15 to 795 feet, and 13 shallow piezometers, were installed throughout the PAPA to characterize the groundwater system.

Air-rotary, mud-rotary, and air-hammer drilling methods were used to complete the 30 study wells in 2009-2010, with potable water, foam, and/or mud used during the drilling process to facilitate removal of cuttings and maintain an open hole for casing installation (AMEC 2012). Waste drill water and cuttings were disposed off-site at selected sites where required by BLM after laboratory analysis of representative samples.

For the study wells completed in alluvium and the Wasatch Formation, well casing depths are in the following ranges:

- Alluvium (6 wells): 15 to 38 feet below ground surface (bgs); and
- Wasatch Formation (22 wells): 150 to 795 feet bgs.

In general, casing for study wells that extend to total depth consists of either 4-inch diameter polyvinyl chloride (PVC; alluvial and shallow Wasatch wells) or 5-inch diameter steel (deeper Wasatch wells). The 4-inch diameter Schedule-80 PVC casing (threaded-and-coupled) used for the study wells has 0.020-inch-opening factory-slotted PVC screen. The deeper study wells that were installed with 5-inch diameter black steel casing (welded) have stainless-steel factory wire-wrap screen (0.020-inch opening) sections. Lithologic and well completion logs for these wells are found in AMEC (2012).

Groundwater encountered in four of the study wells located near the New Fork or East Fork rivers flowed at the surface and, therefore, were fitted with shut-in valves at the surface or packers in the well casings to prevent flowing conditions. A few study wells had measureable concentrations of lower explosive limit (LEL) vapors (e.g., methane) during drilling and groundwater sampling activities.

2.2 PARAMETERS IDENTIFIED FOR GROUNDWATER QUALITY MONITORING

Section 4.3 of the Plan (NewFields 2016) explains the process used to identify parameters for the GMP. Two flow charts (Figures 4-10 and 4-11 in NewFields 2016) show the logic used to satisfy GMP water quality-related objectives and how both a Core List and Supplemental List of parameters were

developed for the GMP. Parameters selected for the Core and Supplemental Lists are presented in Table 1 of Appendix K of the WOGCC Rules. Core List and Supplemental List parameters are:

- **Core List**: chloride, total dissolved solids (TDS), barium, boron, manganese, strontium, benzene, toluene, ethylbenzene, xylenes (total), naphthalene, total petroleum hydrocarbons – diesel range organics (TPH-DRO), total petroleum hydrocarbons – gasoline range organics (TPH-GRO), and dissolved methane (gas).
- **Supplemental List**: alkalinity, bromide, calcium, potassium, and sodium.

3.0 MONITORING AND SAMPLING PROCEDURES

The purpose of this section is to describe the procedures used to: select monitoring locations; install and develop new monitoring wells; collect groundwater samples; handle and transport samples; and document field activities. Several annexes to this SAP contain supporting information including standard operating procedures for field activities (**Annex 4C-1**); field forms (**Annex 4C-2**); and, driller's logs for existing GMP wells (**Annex 4C-3**).

3.1 MONITORING LOCATION SELECTION

For purposes of the GMP, the PAPA well network for monitoring has been divided into three principal zones: River Corridor Envelope, North Zone, and South Zone (**Figure 4C-2**). The River Corridor Envelope is the zone designated to have the greatest environmental sensitivity and the greatest relative risk of being impacted. The bounds of the North and South Zones are designated by borders of the core natural gas development areas and the intersection with the River Corridor Envelope. A total of 41 wells are included in the GMP network: 21 existing wells and 20 new wells (**Figure 4C-3**).

Existing Wells

The following are existing industrial or monitoring wells that are included in the groundwater monitoring network for the Plan. **Table 4C-1** lists key information for these wells, and **Annex 4C-3** contains available well logs.

- North Zone: 12 wells in the Wasatch HSU (MS 11-21; MS 12-28; MS 12-33; MS 13-5; MS 15-20; MS 3-17; MS 3-20; MS 3-22; MS 6-16; SP 14-20; SP 15-17; SP 8-32); all of these wells are industrial supply wells owned by QEP or Ultra, ranging in depth from 772 to 1,200 feet bgs. Refer to **Figure 4C-4** for North Zone wells.
- South Zone: five wells in the Wasatch HSU (AN 5-4; BO 14-32; RB 15-31; WB 11-4; WB 8-25); all of these wells are industrial supply wells owned by Ultra or Linn Energy, ranging in depth from 200 to 863 feet bgs. Refer to **Figure 4C-5** for South Zone wells.
- River Corridor Envelope: four wells in the Alluvial HSU (X-4a-A; RCE-14; RCE-15; RCE-16); these wells are on Ultra drill pads, ranging in depth from 13 to 18 feet bgs. Refer to **Figure 4C-6** for existing River Corridor Envelope wells completed in alluvium.

New Monitoring Wells

The following are new monitoring wells planned for inclusion into the GMP network (**Table 4C-1**):

- North Zone: one well in the Wasatch HSU (GMPN-01); this well has an anticipated depth of about 250 to 300 feet bgs. Refer to **Figure 4C-4** for North Zone wells.
- South Zone: six wells in the Wasatch HSU (GMPS-01 through GMPS-06); these wells have an anticipated depth range of 100 to 600 feet bgs. Refer to **Figure 4C-5** for South Zone wells.
- River Corridor Envelope: 13 wells in the Wasatch HSU (RCE-01 through RCE-13); these wells have an anticipated depth range of 100 to 200 feet bgs. Refer to **Figure 4C-7** for River Corridor Envelope wells proposed for completion in the Wasatch Formation.

Table 4C-1. Existing and Proposed GMP Wells

Well Name	Ownership / Surface Manager	HSU	Northing	Easting	Well Depth (ft bgs)	Reported Depth to Water (ft bgs)	Casing Type / Diameter (in)	Screen Interval (ft bgs)	Pump Type / Depth (ft bgs)
North Zone (12 existing wells + 1 new well) – Analyze for Core List Parameters									
MS 11-21	QEP/BLM	Wasatch	15,523,864	1,950,885	910	400	Steel / 6.6	750-910	Sub / 850
MS 12-28	Ultra/BLM	Wasatch	15,518,183	1,950,403	1,020	270	Steel / 9.9	820-1000**	Sub / 928
MS 12-33	Ultra/BLM	Wasatch	15,512,795	1,950,170	1,000	230	Steel / 6	853-979**	Sub / 800
MS 13-5	QEP/BLM	Wasatch	15,538,048	1,944,707	940	UNK	UNK	780-930	Sub / UNK
MS 15-20	QEP/BLM	Wasatch	15,522,558	1,947,624	1,120	560	Steel / 8	660-800**	Sub / 1100
MS 3-17	QEP/BLM	Wasatch	15,531,222	1,946,282	1,200	198	Steel / 8	740-1190	Sub / 1180
MS 3-20	QEP/BLM	Wasatch	15,526,279	1,946,080	940	495	Steel / 6.6	730-930	Sub / 920
MS 3-22	QEP/BLM	Wasatch	15,526,170	1,955,913	772	350	Steel / 6.6	523-772	Sub / 550
MS 6-16	QEP/State	Wasatch	15,529,939	1,951,551	1,000	400	Steel / 6.6	700-1000	Sub / 850
SP 14-20	QEP/BLM	Wasatch	15,552,193	1,937,755	1,000	350	Steel / 6.6	700-1000	Sub / 879
SP 15-17	QEP/BLM	Wasatch	15,557,192	1,938,670	940	520	Steel / 6.6	640-940	Sub / 860
SP 8-32	QEP/BLM	Wasatch	15,543,866	1,940,325	1,090	400	Steel / 8.6	810-1090	Sub / 1080
GMPN-01	Ultra/BLM	Wasatch	15,519,064	1,956,395	250-300*	NA	Steel / 5*	NA	Sub*
River Corridor Envelope (4 existing wells + 13 new wells) – Analyze for Core and Supplemental List Parameters									
RCE-01	Road ROW	Wasatch	15,505,864	1,965,144	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-02	Road ROW	Wasatch	15,504,228	1,962,891	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-03	Road ROW	Wasatch	15,503,108	1,961,134	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-04	Road ROW	Wasatch	15,502,442	1,958,472	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-05	Road ROW	Wasatch	15,501,415	1,956,366	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-06	State	Wasatch	15,498,332	1,952,301	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-07	Road ROW	Wasatch	15,484,849	1,947,143	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-08	Ultra/BLM	Wasatch	15,500,575	1,974,417	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-09	Ultra/Priv.	Wasatch	15,500,028	1,968,814	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-10	Ultra/Priv.	Wasatch	15,499,918	1,965,101	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-11	Ultra/Priv.	Wasatch	15,498,996	1,961,819	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-12	BLM	Wasatch	15,497,859	1,957,639	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-13	Ultra/Priv.	Wasatch	15,493,783	1,960,404	100-200*	NA	PVC / 3*	NA	Bladder*
RCE-14	Ultra/Priv.	Alluvial	15,500,425	1,958,285	13	5.5	PVC / 2	NA	Bladder*
RCE-15	Ultra/Priv.	Alluvial	15,502,653	1,964,758	13	3.5	PVC / 2	NA	Bladder*
RCE-16	Ultra/Priv.	Alluvial	15,503,471	1,966,973	13	6.4	PVC / 2	NA	Bladder*
X-4a-A	Ultra/Priv.	Alluvial	15,501,438	1,962,124	20 / 18	4.3	PVC / 4	NA	Bladder*
South Zone (5 existing wells + 6 new wells) – Analyze for Core List Parameters									
AN 5-4	Linn/BLM	Wasatch	15,444,730	2,014,015	550	90	Steel / 6.6	430-550	Sub / 465
BO 14-32	Ultra/BLM	Wasatch	15,479,112	1,977,944	700	65	Steel / 6	380-580**	Sub / 672
RB 15-31	Linn/BLM	Wasatch	15,447,371	2,005,747	740	UNK	Steel / 6	530-698	Sub / 628
WB 11-4	Ultra/BLM	Wasatch	15,473,663	1,983,316	800	187	Steel / 6.6	570-800**	Sub / 768
WB 8-25	Ultra/BLM	Wasatch	15,455,310	2,001,889	670	290	Steel / 6.6	550-670	Sub / 640
GMPS-01	Ultra/BLM	Wasatch	15,486,528	1,971,152	100-200*	NA	Steel / 5*	NA	Sub*
GMPS-02	Ultra/BLM	Wasatch	15,481,841	1,972,550	150-250*	NA	Steel / 5*	NA	Sub*
GMPS-03	Ultra/BLM	Wasatch	15,472,189	1,988,568	300-400*	NA	Steel / 5*	NA	Sub*
GMPS-04	Ultra/BLM	Wasatch	15,468,253	1,971,107	400-500*	NA	Steel / 5*	NA	Sub*
GMPS-05	Ultra/BLM	Wasatch	15,462,303	1,992,215	500-600*	NA	Steel / 5*	NA	Sub*
GMPS-06	Ultra/BLM	Wasatch	15,458,969	1,993,604	500-600*	NA	Steel / 5*	NA	Sub*

Note: SCCD – Sublette County Conservation District; HSU – hydrostratigraphic unit; ft – feet; bgs – below ground surface; in - inches; sub – submersible pump (electric powered); bladder – bladder pump (air/gas powered); NA – not applicable; UNK – unknown or not reported; Priv. – private; Road ROW – County Road Right-of-Way; * - proposed or anticipated for new wells; ** - multiple shorter screen intervals within the reported overall interval. If two values are reported for Well Depth, the first value is depth drilled and second value is depth cased. See **Figures 4C-3** through **4C-7** for well locations.

3.2 Permitting Requirements

Several permits may be required prior to completing new monitoring wells, especially those located on government-administered land. Wells located on private land also require landowner permission. Specific permits required prior to completing some of the new monitoring wells may include:

- Right-of-way permit from BLM for well sites located on BLM-managed land (not including existing gas drill pads).
- Sundry permit from BLM for well sites located on existing gas drill pads that are on BLM-managed land.
- Wildlife exception permit from BLM for wells proposed on BLM-managed land where certain wildlife restrictions may be in force.
- WOGCC permit for wells located on existing gas drill pads.
- Wyoming SEO permit for monitoring wells with casing larger than 4 inches in diameter.
- Wyoming State Lands permit for wells located on state-managed land.
- Wyoming DEQ permit-by-rule applies to wells used to characterize subsurface conditions at sites where pollution is not known to exist.
- Right-of-way permit from Sublette County for drilling within Paradise Road ROW.

Based on the "Ownership / Surface Manager" column in **Table 4C-1**, a total of eight new monitoring wells would be located on BLM-managed land with Ultra or QEP leases. Six of the new monitoring wells would be located in Sublette County Road ROW; four new wells would be on private land owned by Ultra; one new well would be on BLM-managed land (access road to QEP pad); and one new well would be on state land.

3.3 Drilling and Well Completion Procedures

The new monitoring wells for the GMP must meet the Water Well Minimum Construction Standards, where applicable, specified in the Wyoming SEO (2011) Regulations and Instructions, Part III, revised June 2011; Well Construction Standards in the Wyoming DEQ (2012b) WQD Water Quality Rules and Regulations, Chapter 26; and Wyoming DEQ/WQD Additional Recommendations for the Design, Construction, and Installation of Monitor Wells, Chapter 3, Water Quality Rules and Regulations (DEQ 2012c).

All new monitoring wells will be completed in the Wasatch Formation. New wells located in the North and South Zones are estimated to be installed to depths in the range of about 100 to 600 feet bgs, and those in the River Corridor Envelope will be completed to depths in the range of about 100 to 200 feet (**Table 4C-1**). The 13 wells to be installed in the River Corridor Envelope will be completed with 3-inch diameter Schedule-80 PVC (standard pipe specifications in ASTM D1785) casing (threaded-and-coupled) and 0.020-inch-opening factory-slotted PVC screen. The six wells to be installed in the North and South Zones will be completed with 5-inch diameter black steel casing (threaded-and-coupled or welded) including stainless-steel factory wire-wrap screen (0.020-inch opening) sections. All steel casing will be

cleaned using a brush and detergent (e.g. Simple Green®), followed by steam cleaning inside and outside, and prior to the casing being placed in each borehole. Blank PVC casing and PVC and stainless steel screens will be new and certified clean by the manufacturer. **Figures 4C-8** and **4C-9** are schematics of a typical well completion for the new PVC-cased and steel-cased monitoring wells, respectively.

Drilling will be performed using air-rotary, mud-rotary, or air-hammer methods, with potable water foam, and/or mud used during the drilling process to facilitate removal of cuttings and maintain an open hole for casing installation. Biodegradable foam and/or bentonite mud may be required during drilling to remove cuttings if water is unsuccessful. For well locations in the South Zone where dissolved methane concentrations in groundwater in excess of 1 milligram per liter is anticipated based on results of AMEC (2013), mud-rotary methods may be used to minimize the potential for explosive concentrations of methane encountered during drilling. The foam and bentonite products must be hydrocarbon-free and metal-free. Drilling compound or pipe dope used on the drill rig must be a NSF/ANSI certified biodegradable, nontoxic, metal-free, and hydrocarbon-free vegetable-based fluid.

Drill cuttings will be logged continuously for lithology while drilling. Unconsolidated materials will be described according to the Unified Soil Classification System as indicated in SOP-15 (**Annex 4C-1**). Once the Wasatch Formation is encountered in each borehole, lithologic descriptions of cuttings (e.g., siltstone, mudstone, shale, sandstone) will be continuously logged and recorded. Other information recorded will include: rock color; grain size; description of induration or consolidation; descriptions of any fracture zones encountered; water-bearing intervals; estimated water yields; and an estimate of any potable water added to borehole to aid in cuttings removal. A field guide for logging water-well boreholes is provided in **Annex 4C-2**.

For all new wells to be completed in the Wasatch Formation, an approximately 20-ft length of screen will be placed within one or more zones of sandstone that are located in the uppermost part of continuously saturated Wasatch Formation. A silica-sand filter pack will be emplaced in the annulus of the borehole via tremied slurry made with potable water from the bottom of the annulus to 5 feet above the top of well screen. Bentonite chips or pellets will be installed into the borehole annulus above the sand filter pack to a depth of 5 feet above the top of the sand pack, and hydrated with potable water. Neat cement grout slurry made with potable water will be pumped into the annulus using a tremie pipe from the bottom to top of the remaining open annulus in one continuous upward operation.

Neat cement is comprised of Class A or B Portland Cement (ASTM C150 or API 10B) with a recommended water to cement ratio of 4.5 to 6.5 gallons of clean water per 94-pound sack of cement. This mixture will weigh about 15 pounds per gallon. Approximately 1-2% by weight of bentonite can be added to the cement slurry to increase set volume, reduce shrinkage, decrease density, and decrease water loss. Casing centralizers will be used on the casing and screen to ensure an even annular space in the borehole around the casing. At a minimum, centralizers will be placed at the top of the screen, at the top of the casing and at approximate 60-foot intervals on the blank well casing (**Figures 4C-8** and **4C-9**).

Monitoring wells will be finished at the surface with an above-ground metal monument equipped with a locking lid. The monument will be concreted in place. Concrete outside the monument will be graded away from the well to shed water away from the well. Top-of-casing elevation, ground surface elevation,

and coordinates of the new monitoring wells will be surveyed by a Wyoming-licensed professional land surveyor relative to UTM Zone 12.

Additional information on procedures for monitoring well construction includes the following:

- SOP-15 (**Annex 4C-1**) provides a general description of monitoring well construction procedures.
- **Figures 4C-8** and **4C-9** show schematics of a typical well completion for the new PVC-cased and steel-cased monitoring wells, respectively.
- **Section 3.6.8** (below) describes how investigation derived waste will be handled, including drill cuttings and water.
- Two field forms – lithologic and well completion log and monitoring well installation record – that will be used to document results of drilling and well completion are located in **Annex 4C-2**.
- A representative sample of pipe dope used on each drill rig will be collected and analyzed for the Core List of parameters, excluding dissolved methane.

Due to the potential for combustible gas concentrations in boreholes during and after drilling the new monitoring wells, a combustible gas indicator (CGI) will be used to monitor the drill site. If CGI readings are ≥20% of the lower explosive limit (LEL), drilling operations will be suspended until the source of the gas vapors is identified and mitigated. Bentonite drilling mud may be required during drilling operations to prevent the movement of explosive vapors into the borehole. The environmental consultant and drilling contractor retained by Ultra and QEP to install the monitoring wells will follow a health and safety plan that meets their safety requirements, and those of BLM and/or the surface owner(s).

3.4 Well Development Procedures

Once installed, a minimum of 10 casing volumes of water will be removed by the surge-and-bail or surge-and-pump technique (SOP-13 and SOP-18, **Annex 4C-1**) to develop each new well and remove excess fines from the screened interval. The quantity of water developed from the well will include the estimated volume of any water added to the borehole during drilling. The goal is to obtain water from the aquifer adjacent to the well screen that has low turbidity (<10 nephelometric turbidity units [NTU]). Water samples will not be taken immediately after well development. The well will be allowed to equilibrate to initial static water level conditions for at least 24 hours prior to sampling. A field form for documenting well development procedures and results is included in **Annex 4C-2**. **Section 3.6.8,** below, describes how investigation derived waste will be handled, including development water.

3.5 Groundwater Monitoring Parameters

As described in **Section 2.4** and in Section 4.3.1 of the Plan (NewFields 2016), parameters identified for monitoring under the GMP were established using a rigorous assessment process, resulting in a Core List and Supplemental List of parameters. These parameters (also referred to as analytes or constituents) are listed in **Table 4C-2**, along with analytical methods, sample container and preservative requirements, filtration requirements, reporting limits, and sample holding times. In addition to the inorganic

compounds and hydrocarbons listed in **Table 4C-2**, groundwater samples will also be analyzed for dissolved methane (gas).

As a result of the process used to establish GMP groundwater quality parameters (refer to Section 4.3.1 in NewFields 2016), the following parameters in WOGCC's Table 1 of Appendix K (WOGCC 2014) will not be analyzed because they do not meet objectives established for the GMP: fluoride, sulfate, total phosphorus, nitrate+nitrite, iron, magnesium, selenium, iron reducing bacteria (IRB), and sulfate reducing bacteria / slime forming bacteria (SRB/SFB).

Table 4C-2. Laboratory Parameters, Methods, and Sample Requirements for the GMP

Analyte	CAS #	Field Method	Analytical Method	Sample Containers	Preservatives	Reporting Limit	Holding Time
Inorganic Compounds							
Alkalinity (total bicarbonate, and carbonate as $CaCO_3$)	471-34-1	Unfiltered	SM 2320b	2x 250-mL poly	Cool to 4˚C	10 mg/L	14 days
Bromide	24959-67-9		EPA 300.0 or 9056			0.1 mg/L	28 days
Chloride	16887-00-6		EPA 300.0 or 9056			0.2 mg/L	28 days
Total Dissolved Solids	---		SM 2540 C	1x 500-mL poly		10 mg/L	7 days
Barium	7440-39-3	0.45-micron (µm) filter in field	EPA 200.7/200.8 or SW 846 6010 or SW 846 6020	1x 250-mL poly	Nitric Acid (HNO_3) to pH <2 Cool to 4˚C	0.05 mg/L	180 days
Boron	7440-42-8					0.005 mg/L	
Calcium	7440-70-2					1.0 mg/L	
Manganese	7439-96-5					0.001 mg/L	
Potassium	7440-09-7					1.0 mg/L	
Sodium	7440-23-5					1.0 mg/L	
Strontium	7440-24-6					0.01 mg/L	
Hydrocarbons							
Benzene	71-43-2	Unfiltered	SW 846 8260B	3x 40-mL VOA vials (no headspace)	Hydrochloric Acid (HCL) to pH<2 Cool to 4˚C	0.001 mg/L	14 days
Ethylbenzene	100-41-4					0.001 mg/L	
Toluene	108-88-3					0.001 mg/L	
Xylenes, Total	---					0.003 mg/L	
Naphthalene	91-20-3					0.001 mg/L	
TPH-DRO	---		EPA 8015D with silica gel cleanup	2x 1000-mL glass	Sulfuric Acid (H_2SO_4) to pH<2; Cool to 4˚C	0.5 mg/L	7 days
TPH-GRO	---		EPA 5035/8015D	3x 40-mL VOA vials (no headspace)	Hydrochloric Acid (HCL) to pH <2; Cool to 4˚C	0.02 mg/L	14 days
Gases							
Dissolved Methane	74-82-8	Unfiltered	RSK175	3x 40-mL VOA vials (no headspace)	Cool to 4˚ C	0.026 mg/L	14 days
Dissolved Ethane	4-84-0						
Dissolved Propane	74-98-6						

Analyte	CAS #	Field Method	Analytical Method	Sample Containers	Preservatives	Reporting Limit	Holding Time
Gas Compositional Analysis (to be used only for the initial sample from a new well where dissolved methane >5 mg/L)							
Fixed Gases C1-C6	---	Dissolved Gases	RSK175	Specialized (lab supplied)	Benzoalkonium	0.026 mg/L	14 days
Stable isotropic concentration of the carbon (^{12}C and ^{13}C) and hydrogen (^{1}H and ^{2}H) in the methane	---		Laboratory Specific SOP			Variable	28 days

Notes:

TPH-DRO – Total Petroleum Hydrocarbons Diesel Range Organics; TPH-GRO – Total Petroleum Hydrocarbons Gasoline Range Organics; VOA – Volatile Organic Analysis; mL – milliliters; mg/L – milligrams per liter; SOP – standard operating procedure; °C – degrees Celsius.

Modified from: Wyoming Oil and Gas Conservation Commission (WOGCC 2014), Table 1 in Appendix K (Sampling and Analysis Procedures for the Wyoming Oil and Gas Conservation Commission, Groundwater Baseline Sampling, Analysis, and Monitoring Program).

The following analytes were removed from WOGCC Table 1 in Appendix K due to site-specific development of the Core and Supplemental lists in Section 4 of the Plan (NewFields 2016): fluoride, sulfate, total phosphorus, nitrate+nitrite, iron, magnesium, selenium, iron reducing bacteria (IRB), and sulfate reducing bacteria/slime forming bacteria (SRB/SFB). Note that dissolved ethane gas, dissolved propane gas, fixed gases C1-C6, and stable isotopes of carbon and hydrogen are analyzed only if the dissolved methane gas concentration is >5 mg/L in the initial sample collected from a new monitoring well.

Core and Supplemental List parameters are:

Core List	Supplemental List
Chloride	Alkalinity
TDS	Bromide
Barium	Calcium
Boron	Potassium
Manganese	Sodium
Strontium	
Benzene	
Toluene	
Ethylbenzene	
Xylenes, total	
Naphthalene	
TPH-DRO	
TPH-GRO	
Dissolved Methane (gas)	

Note: TDS – total dissolved solids; TPH –total petroleum hydrocarbons; DRO – diesel range organics; GRO – gasoline range organics.

The 41 wells included in the GMP will be sampled annually in the summer for parameters listed on the Core List and/or Supplemental List. All wells will be analyzed for Core List parameters; whereas, wells located in the River Corridor Envelope will also be analyzed for Supplemental List parameters. As noted in Section 4.3.2 of the GMP (NewFields 2016), the four alluvial monitoring wells will also be sampled at the beginning of each calendar year (semi-annual frequency). In addition, for the new monitoring wells and any existing wells in the GMP that have not previously been analyzed for the inorganic compounds, hydrocarbons, and dissolved methane listed in **Table 4C-2**, the initial groundwater sample from these wells will be subject to further analysis if the dissolved methane concentration is greater than 5 milligrams per liter (mg/L). The additional analysis will include dissolved ethane and propane, fixed gases C1-C6, and stable isotopes of carbon and hydrogen in methane as shown on Figure 4-12 in NewFields (2016).

3.6 Groundwater Sampling Procedures

Most of the existing wells in the GMP network are industrial supply wells with submersible pumps installed to facilitate collection of groundwater samples; these include the 17 existing wells in the North and South Zones. Pumps are installed at depths indicated in **Table 4C-1**. Should pumps in existing wells need to be removed for maintenance or replacement, Operators would reinstall set pumps at the approximate middle of the screened interval in the well.

For any existing wells without pumps (including the four alluvial wells), and the 20 new wells yet to be installed, it is anticipated that dedicated pumps will be installed, and that the pumps will be low-flow bladder type pumps for the wells with PVC casing, and electric submersible pumps for the wells with steel casing. Bladder pumps allow for low-flow sampling techniques whereby the intake for the pump is located in the well screen section, and the low-flow pumping rates (1.0 liter per minute (L/min) or less) withdraw formation water directly through the well screen. This low-flow method is endorsed by EPA (1996, 2002, 2010) for obtaining representative groundwater samples from a well. The intake of the bladder pump will be set in the middle of the well screen interval. Dedicated pumps for new wells, along

with associated tubing, hose, and electrical cord, will be new materials that are decontaminated in accordance with SOP-2 (**Annex 4C-1**) prior to placement in the wells.

Groundwater samples will be collected by properly trained field personnel under the supervision of a state-licensed Professional Engineer or Professional Geologist or other qualified professionals upon approval by the WOGCC Supervisor based on training and knowledge of standard industry practices. Much of the general sampling information provided in this section is described further in EPA's "Sampler's Guide" (EPA 2014). A field form to be used for groundwater sampling is included in **Annex 4C-2**.

The laboratory project manager will be directed to provide notification to the Operators or Operator representative (e.g., Primary Environmental Contractor) if the preliminary analytical results indicate any of the following conditions:

1. Presence of thermogenic or mixture of thermogenic and biogenic gas;
2. Methane concentration at or above 5 mg/L; and/or
3. Benzene, toluene, ethylbenzene, and xylene (BTEX) compounds or total petroleum hydrocarbons (TPH) at or above action levels (Table 4C-3) in a water sample.

Table 4C-3. Action Levels for Key Petroleum Constituents

Analyte	Action Level
Benzene	0.005 mg/L
Toluene	1.0 mg/L
Ethylbenzene	0.7 mg/L
Xylenes, Total	10 mg/L
TPH-DRO	1.0 or 10 mg/L
TPH-GRO	6.6 mg/L

Note: Action levels are those specified in Section 2.3 of Appendix K (WOGCC 2014) with two exceptions: in December 2014, Wyoming DEQ (2014) lowered its groundwater cleanup level standards for TPH-GRO and TPH-GRO and these changes are reflected in **Table 4C-3**. Action levels are based on EPA (2009) Maximum Contaminant Levels (MCLs) or Wyoming DEQ (2014) Voluntary Remediation Program (VRP) groundwater cleanup levels for total petroleum hydrocarbons. TPH = total petroleum hydrocarbons; DRO = diesel-range organics; GRO = gasoline-range organics; mg/L = milligrams per liter.

3.6.1 Well Purging

Section 2.3.1 of Appendix K in the WOGCC Rules states that a groundwater sample is considered representative of the aquifer being monitored when the well has been purged to remove stagnant water prior to collection of a sample for laboratory analysis. Two of the four purging methods specified in Appendix K of the WOGCC Rules generally apply to this GMP, and were slightly adapted as follows:

1. Stabilization of Parameters Method: For the 17 existing industrial water supply wells that are included in the GMP, purging of groundwater will proceed until the field parameters have

stabilized (see below), after which the sample can be collected for laboratory analysis. The field parameters should be measured every 5 minutes, with a minimum of six parameter measurements completed before stabilization is determined. Of the 17 existing water supply wells in the GMP, 13 wells have the existing submersible pumps located within the screen interval (**Table 4C-1**). For the other four wells, two wells have the pumps above and two wells have the pumps below the screen intervals. For this method, a minimum of three well screen interval volumes will be removed prior to sample collection (this criterion is in addition to the WOGCC method description). For example, 6-inch diameter well MS 11-21 has a screen interval of 750-910 feet; total volume of water in the screen interval is 240 gallons X 3 = 720 gallons. The water sample, therefore, would be collected after removal of 720 gallons and stabilization of parameters.

2. Low-Flow Sampling Method: When purging a well using low-flow sampling techniques (e.g., bladder pump), the goal is minimal drawdown (<0.3 foot) of the groundwater level during purging. A groundwater sample can be collected for laboratory analysis after at least two or three well screen interval volumes of water have been removed and field parameters have stabilized (see below). The goal is to exchange water residing in the well screen interval with water in the aquifer, and the low flow method consists of pumping water directly from the aquifer adjacent to the well screen (not entire well casing). It is assumed that the one casing volume criterion specified by WOGCC for sampling low-yield wells can be modified to that portion of the well with the screen interval. Typically, two to three well screen volumes are removed using the low-flow sampling method prior to sampling to achieve parameter stabilization. This method will apply to new monitoring wells for which a dedicated low-flow sampling pump (e.g., bladder pump) will be installed inside the well screen interval.

Note the following well casing diameter vs. volume values: 2-inch casing = 0.163 gallon/foot (gal/ft); 3-inch casing = 0.367 gal/ft; 4-inch casing = 0.653 gal/ft; 6-inch casing = 1.47 gal/ft; and 8-inch casing = 2.61 gal/ft.

The types of pumps expected to be used for purging and sampling are listed in **Table 4C-1**. The following field parameters will be monitored on a regular basis during purging: temperature, pH, oxidation-reduction potential (ORP), specific conductance (SC), dissolved oxygen (DO), and turbidity. Water quality meters for these parameters will be calibrated at the beginning of each sampling day in accordance with manufacturer's directions and SOP-7 through SOP-10 and SOP-13 (see **Section 3.6.6** and **Annex 4C-1**). When the field parameters have stabilized for three consecutive readings, a groundwater sample can be collected for laboratory analysis in accordance with the other conditions described above. Stabilization can be demonstrated by the following conditions:

- Temperature: ±10%;
- Turbidity: ±10% (if >10 NTU);
- DO: ±10% (if >0.5 mg/L);
- SC: ±10%;
- ORP: ±10 millivolts (mV); and
- pH: ±0.2 standard units.

Existing industrial water supply wells will be sampled using a slip-stream method at the well head from discharge piping connected to submersible fixed-rate pumps. If not already equipped, a brass or stainless steel quill-type sampling port will be installed in the bottom of the discharge piping at the well head. The sampling port will be equipped with a ball valve to control flow rates to approximately 100 milliliters per minute for sampling. The port will have a nipple or other type of connection to allow disposable tubing to be attached between the sample port and a flow-through cell. The flow-through cell will be equipped with various probes/sensors to measure field water quality parameters.

During purging, field parameters will be measured in a flow-through cell equipped with applicable sensors in accordance with SOP-7, -8, -9, and -10 (**Annex 4C-1**). A field form to document well purging procedures and results is included in **Annex 4C-2**. Any purged groundwater that has a visible sheen or contains immiscible liquids (e.g., liquid phase hydrocarbons) will be containerized in an appropriately labeled 55-gallon drum, sampled, and staged pending receipt and review of laboratory results. Purged groundwater that does not have a sheen or immiscible liquids will be thin-spread on the ground surface near the GMP well, unless there are any restrictions on government-managed land.

3.6.2 Sample Collection

For this GMP, groundwater samples will be collected on an annual basis during the summer season (refer to Section 4.3.2 in NewFields 2016). The four alluvial monitoring wells will also be sampled at the beginning of each calendar year. Groundwater samples will be collected immediately after purging each well. Groundwater sampling procedures are described in SOP-12 (**Annex 4C-1**), and a field form to document sampling information is included in **Annex 4C-2**. The parameters to be analyzed by the laboratory are listed in **Table 4C-2**, including analytical methods, sample container and preservative requirements, filtration requirements, laboratory reporting limits, and sample holding times.

Prior to collecting a groundwater sample from each well, a depth to water measurement will be obtained in accordance with SOP-5 (**Annex 4C-1**). The water level indicator tape will be decontaminated before each measurement (see SOP-2; **Annex 4C-1**). All well measuring points will be surveyed and permanently marked. Using the water level indicator, depth to water will be measured from the measuring point to the nearest hundredth of a foot. For wells that do not allow use of a water level indicator probe inside the casing (e.g., impediments for probe access due to electrical pump power cords, discharge piping, well-head access restrictions), a sonic-type water level indicator will be used. When using a sonic water level meter, depth to water readings in at least five wells with varying depths must be correlated with measurements made with a water level indicator tape. The difference between the two measurements will be linear (see AMEC 2012), and a correction factor will be calculated and applied to the water level data obtained using the sonic meter.

Water levels will also be recorded remotely in selected new monitoring wells being installed for the GMP. Solinst Leveloggers® (water pressure transducers) used by the Operators (Ultra and QEP) for the Hydrogeologic Data Gaps Investigation (AMEC 2012) will be deployed in the following new monitoring wells to measure long-term groundwater elevations in the PAPA:

- North Zone: well GMPN-01
- River Corridor Envelope: wells RCE-03, RCE-10, and X-4a-A
- South Zone: well GMPS-05

Barometric pressure sensors (Barologgers®) will be installed in well GMPN-01 in the North Zone and in well GMPS-05 in the South Zone to collect data to compensate for barometric pressure changes measured by the submerged Leveloggers throughout the PAPA. Each Levelogger and Barologger will be programmed to log data on a daily basis to evaluate potential fluctuations in groundwater elevations and barometric pressure.

Leveloggers and Barologgers will be attached to J-plugs and PVC well caps using eye-bolts and suspended below the groundwater surface using a non-stretch Kevlar® cord. Well casing caps will be left slightly loose (i.e., not air tight) or have a small hole to allow air in well casings to be in equilibrium with atmospheric pressure.

After the static water level in each well is measured manually with a water level indicator prior to sampling, the Leveloggers and Barologgers will be retrieved to download data. After data are downloaded, each transducer will be reset and re-deployed. Data will be incorporated into the Plan's data management system and used to develop long-term groundwater hydrographs for the PAPA.

For wells with existing submersible pumps (**Table 4C-1**), the sample bottles will be filled directly from the sampling port, using a low flow rate to minimize water turbulence and loss of volatile organic compounds (VOC). For existing wells without permanent power hookup, a portable generator will be connected to the pump, with the generator located away and downwind from the sampling point.

For wells to be equipped with a low-flow bladder pump or submersible pump, groundwater samples will be collected directly from the discharge tubing. The smaller VOA vials will be filled first using a reduced pumping rate, followed by filling the larger sample bottles for inorganic compounds and TPH-DRO.

Unfiltered samples will be collected directly from the sampling point into clean, laboratory-provided, and preserved (if required) sample containers (**Table 4C-2**). Care will be taken when collecting the sample to minimize agitation when filling the sampling containers, and not to overfill sample containers containing preservatives. Samples collected for volatile constituents, such as BTEX and TPH-GRO, will be collected into VOA vials with no headspace. If air bubbles are observed after placing on the cap, a new sample will be collected into a fresh bottle.

For samples that require filtration (SOP-11, **Annex 4C-1**), a new disposable 0.45-micron (µm) filter will be used in the field for the seven inorganic compounds listed in **Table 4C-2**. For wells with existing submersible pumps, the filter will be inserted in-line, if possible, or from a decontaminated clean container if not possible for in-line placement. For the wells with bladder pumps, the filter will be inserted in-line for collection of the sample. The in-line filter will be connected to disposable tubing, if applicable, that is then connected to the discharge point.

Groundwater sampling will be conducted by personnel with the proper training and experience. The sampler will wear a new pair of disposable, powder-free latex gloves in order to reduce cross-

contamination of the samples prior to sampling. At a minimum, gloves will be changed between sampling locations and as necessary during the well purging/sampling process to reduce the potential for cross-contamination.

To collect samples for dissolved methane in groundwater, a clean container (decontaminated in accordance with SOP-2, **Annex 4C-1**) of sufficient size (e.g., 5-gallon bucket) will be filled with water from the sampling location. A section of disposable tubing will be connected to the discharge point; and using a step-down valve, a short length of ¼-inch diameter disposable tubing will be connected to the valve. The flow rate through the tubing will be adjusted so that it is low. The dissolved gas sample will then be collected in accordance with procedures specified in SOP-41 (**Annex 4C-1**). If collecting the sample for gas compositional analysis (**Table 4C-2**), the benzalkonium tablet will be quickly inserted into the sample container prior to placing the cap. The filled gas sample container will be checked to be sure there are no air bubbles in the sample. If air bubbles are visible, another sample should be collected. If the water is effervescent, a gas headspace bubble in the VOA vial is acceptable, and the laboratory will be notified to analyze the gas in the vial's headspace. Once collected, dissolved gas samples will be stored and packed upside down in shipping containers

An alternate method to collect samples for dissolved methane analysis is through the use of IsoFlasks® sample containers. The IsoFlasks and sampling procedure were developed by Isotech Laboratories, Inc. (refer to: http://www.isotechlabs.com/products/isoflask/ISOFLASK_SAMPLING.pdf). The IsoFlask is designed to collect and provide proper shipment of groundwater samples for dissolved gas analysis. According to Isotech Laboratories, the unique IsoFlask design will not alter the quantity or isotopic characteristics of dissolved hydrocarbon gases, which makes it appropriate to both quantify gas concentrations and identify the source of methane, ethane, and propane present in groundwater. Influent sample water is supplied by a pressurized system (e.g., supplied by the pump in GMP wells) with an air-tight seal between the pump tubing and IsoFlask. The IsoFlasks are provided for use under a vacuum and contain a bactericide capsule. Approximately 600-700 milliliters of sample are required to fill the IsoFlask. Sample information is recorded onto the IsoFlask with a soft-tipped permanent marker. IsoFlasks are shipped to Isotech Laboratories in a supplied protective box following chain-of-custody procedures described in **Section 3.6.4**.

Due to the potential for combustible gas concentrations inside water wells, a combustible gas indicator (CGI) will be used to survey the workspace around and in the well casing. If CGI readings are ≥20% of the LEL, sampling activities would be suspended until the source of the gas vapors is identified and mitigated (see SOP-42; **Annex 4C-1**).

3.6.3 Sample Handling

The sample containers and preservatives for each laboratory method are specified in **Table 4C-2**. Sample containers will be stored in a cool, dry location, separate from any VOC-containing materials. Sample containers containing laboratory prepared preservatives shall not be used if held on-site for an extended period of time or if exposed to extreme temperature conditions. Once opened, the sample containers will be used immediately. If the container is used for any purpose other than sample collection, it will be discarded.

Samples will be identified with a unique sample identification number (**Table 4C-1**). Sample containers will be labeled using waterproof ink and shall indicate the company, project identifier, sample ID, date, time, sampler, matrix, filtered/unfiltered, and preservative (if any) (SOP-3, **Annex 4C-1**). Sample labels from the laboratory will be used whenever possible. After labeling, samples will be placed in an insulated cooler on ice until packed for shipment to the laboratory. Sample containers will be placed in Ziploc-style baggies and then wrapped in protective packing material (bubble wrap; not foam blocks that many labs use to ship the VOA vials). Sample containers will then be placed in the insulated cooler in an up-right position (with the exception of the dissolved gas samples) and surrounded with sufficient ice to maintain a cooler temperature of ≤4 degrees Celsius (°C) during shipping. Ice will be double bagged into Ziploc-style baggies. If the cooler contains a drain outlet, it will be sealed over with tape on the inside and outside of the cooler prior to sample packing.

All groundwater samples (placed in ice-filled and sealed coolers) will be shipped to the laboratory(ies), along with all appropriate shipping forms under chain-of-custody in accordance with SOP-3 (**Annex 4C-1**). Shipping will comply with shipper, EPA, and U.S. Department of Transportation (DOT) regulations. The chain-of-custody (COC) form (see example form in **Annex 4C-2**) will be placed in a Ziploc-style bag and placed inside the sample cooler. Shipping documents will specify the laboratory analyses for each sample.

Each cooler will be secured with strapping tape and clearly display a shipping label with all appropriate laboratory information in accordance with SOP-4 (**Annex 4C-1**). A completed sample custody seal will be taped onto the outside of each sample cooler such that the seals will be broken when the cooler is opened. All samples submitted for laboratory analysis will be analyzed using standard turnaround times. Upon receipt at the laboratory, the temperature of all coolers will be measured to document proper sample preservation requirements. Therefore, a temperature blank will be placed in each cooler by the laboratory when the sample coolers are shipped to the Project site.

3.6.4 Chain-of-Custody Procedures

All samples will be shipped to the laboratory using proper COC procedures as outlined in SOP-3 and SOP-4 (**Annex 4C-1**) to document the custody, transfer, handling, and shipping of samples. One COC form (see example form in **Annex 4C-2**) will be completed for each cooler of samples, and will contain the following information:

- Sampler's signature;
- Project number;
- Date and time of collection;
- Sample identification number;
- Sample type;
- Analyses requested;
- Number of containers;
- Preservatives;
- Requested turn-around time;

- Observations on sample condition that may be pertinent (i.e., effervescence);
- Signature of persons relinquishing custody, dates, and times;
- Signature of persons accepting custody, dates, and times; and
- Method of shipment and shipping air bill number (if appropriate).

A sample is considered under a person's control when it is in their possession. When custody of a sample is relinquished by the sampler, the sampler will sign and date the COC form and note the time that custody was relinquished. The person responsible for delivery of the samples to the shipping company will sign the COC form, retain a copy of the COC form, document the method of shipment (shipper/airbill number) and send the original and a second copy of the COC form with the samples. The person at the laboratory receiving the samples will sign and date the COC form. Copies of the final COC forms from the laboratory documenting sample custody will be kept with the sampling information.

3.6.5 Field Documentation

Pertinent field investigation and sampling information will be recorded on a daily field log book and appropriate sampling forms to provide a continual record of activities completed each day. All field documentation will be conducted in accordance with SOP-1 (**Annex 4C-1**); field forms are included in **Annex 4C-2**. The field log book and/or data sheet will be completed using permanent ink and contain a complete record of all equipment used, activities conducted, measurements of field parameters per well casing volume produced, calculations, and observations including weather and water odor/color/clarity and effervescence. The information will be sufficient to allow the purging and sampling methods to be reconstructed in sufficient detail to evaluate adequacy of the procedures. Field notes will also include explanations of problems encountered during monitoring activities, and an explanation of any trouble-shooting techniques that were used.

The following specific items will be included in each day's field notes and/or field forms, where applicable to the specific groundwater monitoring activities:

- Field ID (i.e., Pinedale Anticline);
- Date and time of sample collection;
- Weather conditions;
- GPS coordinates of the available water source location;
- API Number(s) for natural gas well(s) associated with the sample location;
- Sample type (initial or subsequent);
- Description of sampling location and condition;
- Sample location ID;
- Sample matrix, number and volume of samples, and preservatives, and analysis requested;
- Health and Safety (H&S) procedures followed including Personal Protective Equipment (PPE) used during sampling, and any H&S problems encountered;
- Decontamination information;
- Equipment calibration information;

- Depth to water and information on use of the available water source prior to sampling and time of measurement since purging began;
- Depth to bottom of the well based on well construction information or on actual measurement (as appropriate);
- Calculations (casing volume, screen volume, flow rate);
- Field parameter measurements;
- Total volume and physical characteristics of the purged water, including odor, color, clarity, particulate matter, effervescence;
- Complete description of equipment used for purging, including type and capacity of pump used and pumping rate used to purge well;
- Name and affiliation of person(s) conducting purging, and any observers on site;
- Field parameter measurements for the final casing volume;
- Listing of photographs taken during sampling; and
- Landowner/Lessee/Operator comments, if any, on water quality or other related issues.

3.6.6 Equipment Calibration

All electronic field instruments (e.g., water quality meters, combustible gas indicator [CGI]) will be calibrated to ensure that each instrument is working properly, and that the results are within the range of acceptability as determined by the manufacturer's specifications. Calibration data will be recorded to maintain a record of the calibration and proof of acceptability.

Equipment used to collect field measurements will be calibrated at the start of each sampling day. More frequent calibration may be necessary, depending on the reliability and inherent stability of the instrumentation, extreme field conditions (weather/climate), continuous or heavy use, or high concentrations of monitored parameters. When field calibration is performed, calibration will be verified and documented at the end of the day.

Results of calibration will be recorded in the field log book or field form referenced in the field log book (see groundwater sampling forms in **Annex 4C-2** that include equipment calibration). Calibration results outside ±5% from the standard will require the calibration procedure to be repeated.

3.6.7 Decontamination

Decontamination of sampling equipment will be performed to ensure the quality of samples collected. To prevent cross-contamination between samples, all non-disposable sampling equipment will be decontaminated on-site between sampling locations using distilled water, Alconox® detergent, and a methanol and/or nitric acid rinse in accordance with SOP-2 (**Annex 4C-1**). Decontamination procedures will be conducted at locations identified prior to sampling and at an appropriate distance from sampling activities. Disposable equipment intended for one-time use will not be decontaminated, but will be disposed as described in SOP-2. Dedicated or disposable equipment will be used whenever possible.

All non-disposable equipment (e.g., instruments, buckets, non-dedicated pumps) will be decontaminated prior to use and between sample locations by using the following procedures:

1. Remove any visible surface contamination with a brush (sludge, sediment, etc.) and rinse with tap water.
2. Wash with a dilute solution of tap water and non-phosphate laboratory grade detergent such as Alconox or equivalent. Pumps and non-disposable tubing must have water pumped through them.
3. Rinse with tap water.
4. Rinse with distilled or deionized water.
5. Allow to air dry, if possible.

Decontaminated equipment should be placed on clean plastic sheeting to dry and then stored in sealed containers or wrapped in aluminum foil or plastic when not in use to prevent contamination from airborne particles.

Heavy equipment (e.g., drill rig and support vehicles) will be decontaminated in conformance with SOP-2 (**Annex 4C-1**). Steel well casing will be cleaned using a brush and detergent (e.g., Alconox® or Simple Green®), followed by steam cleaning inside and outside, and prior to the casing being placed in each borehole. Blank PVC casing and PVC and stainless steel screens will be new and certified clean by the manufacturer. All equipment will be decontaminated prior to arriving on site and before exiting a drilling location. Water for decontamination will be supplied from a potable water source (e.g., Pinedale, Wyoming municipal water supply). Decontamination should be done far enough away from the area of sampling so that rinsate generated does not affect future anticipated samples as part of the investigation. The area should also allow for the infiltration of the rinsate into the soil. If field personnel observe any oily residue associated with rinsate, the rinsate will be containerized until proper disposal can be determined in consultation with DEQ and BLM.

Decontamination procedures will be recorded daily in the field log book or field form referenced in the field log book.

3.6.8 Investigation Derived Waste

Investigation derived waste will be handled according to SOP-25 (**Annex 4C-1**). Disposable field equipment (e.g., gloves, filters, valves, tubing) shall be bagged and disposed of as municipal solid waste. Unused sampling containers and preservatives shall be returned to the laboratory, or disposed of as municipal waste. Unused preservatives requiring disposal will be diluted with water and disposed into a municipal sewer system. Preservatives should not be disposed of in concentrated form or directly onto the ground.

Unless otherwise required differently by state or federal agencies, development and purge water will be discharged onto the ground at least 20 feet from and down-gradient of the water source and in a location designated by the landowner or land manager (e.g., BLM). Decontamination water should be collected and disposed of down-gradient from the monitoring well. Development, purge, and

decontamination water, if disposed of onto the surface, shall be discharged in a location to allow for infiltration of the water.

Unless otherwise required differently by state or federal agencies, drilling fluids and water generated from new wells will be discharged to the ground surface in the vicinity of the well location for evaporation and infiltration of the water-based fluids. All surface discharge areas should be selected for infiltration capability and should not allow for migration of discharge water to a surface water body. Drill cuttings will be thin-spread on the ground surface near the well unless impacts are observed during the drilling process. The drilling sites will be reclaimed to approximate pre-disturbed conditions.

3.7 Quality Assurance

Quality Assurance/Quality Control (QA/QC) procedures will be followed in accordance with the Quality Assurance Project Plan (QAPP) in **Appendix 4-D** (NewFields 2016). Data quality will be considered adequate if sampling was conducted according to this SAP, samples were analyzed by approved analytical methods by an accredited/certified laboratory, and a thorough data quality review of field and laboratory data was conducted.

Samples will be analyzed by a laboratory or laboratories that are accredited by the National Environmental Laboratory Accreditation Program (NELAP) or American Association for Lab Accreditation (A2LA) for the analytical methods that will be used as part of the GMP. Analytical methods will conform to approved EPA test methods such as Test Methods for Evaluating Solid and Hazardous Waste (SW-846), or other approved methods such as Standard Methods (SM) for the Examination of Water and Wastewater.

3.7.1 Quality Assurance (QA) Samples

Quality control (QC) samples for this investigation will be collected in accordance with SOP-24 (**Annex 4C-1**), the QAPP (**Appendix 4-D**; NewFields 2016), and as described in this SAP. All field sampling programs require the collection of additional samples to provide quality control for the field or laboratory procedures. These include field duplicates, trip blanks, and equipment rinsate blanks. A temperature blank also will be placed in each cooler by the laboratory when the sample coolers are shipped to the Project site.

A description of each of the various QC sample types is provided below. **Table 4C-4** summarizes the minimum rate at which QC samples must be collected for the GMP.

Table 4C-4. Minimum QA/QC Samples for the GMP

Medium	Duplicates[1]	Trip Blanks[2]	Equipment Rinsate Blanks[1]
Groundwater	1 duplicate in 20 natural samples	One trip blank bottle set per daily set of sample shipment containers containing VOC samples	1 per 20 decontamination procedures

[1] Duplicate and rinse blank samples are collected at the minimum rate of 1 per 20 samples. If fewer than 20 samples are collected, one duplicate sample and one rinse blank sample (if decontamination procedures are performed) must be collected.

[2] Trip blanks are prepared in the laboratory or at another off-site location from distilled or deionized water. They are never prepared on-site, or from soils or other solid material.

Field duplicate samples are independent samples of the same medium collected at the same time from the same location. Duplicate samples will be collected for analysis of all the same analytes as the parent sample. Duplicates are submitted for analysis "blind", meaning that they will not be identified to the laboratory as duplicate samples. The duplicate samples will be identified with a nonexistent sample location ID that is similar to, but different from the other sample location IDs at the site. All other labeling shall be identical to the investigative samples except that a strike-out line will be placed for the sample collection time. The true identity of the duplicate samples shall be recorded in the field logbook, but not on the COC form or sample labels and tags that are sent to the laboratory.

Trip blanks are required only when samples are collected for analysis of VOCs (i.e., BTEX). They are prepared from analyte-free (deionized) water by the laboratory, and are transported to the sampling site with the VOC sample bottles for the investigative sampling. They are kept with the samples throughout the sampling program and are shipped for analysis with the samples. They are not opened on site, and are designed to evaluate VOC contamination encountered within the coolers during the shipping and handling procedures. Trip blanks are prepared in 40 ml VOA vials with Teflon septum lids, and must be chilled and handled in the same manner as a water sample for VOC analysis. A trip blank set is required per each daily set of shipping containers or coolers containing VOC samples. Trip blanks will be analyzed for BTEX.

Equipment rinsate blanks are obtained from the last rinse of analyte-free (deionized) water during decontamination of sample collection equipment. No extraordinary decontamination procedures will be followed when a rinsate blank is collected. The date and time of collection will be noted, as well as the ID number of the investigative sample collected just prior to decontamination, and the ID number of the next sample collected with the decontaminated equipment. If dedicated or disposable equipment is used, rinsate blanks need not be collected. Equipment rinsate blanks will be analyzed for metals and BTEX.

If contamination is detected in a rinsate blank, extensive re-sampling may be required, based on the rate of rinsate blanks collected (e.g., 20 locations re-sampled if rinsate blanks are collected at the rate of 1 per 20 samples; 10 locations resampled if rinsate blanks are collected at the rate of 1 per 10 samples).

Also as previously stated, a temperature blank will be placed in each cooler by the laboratory when the sample coolers are shipped to the Project site. Upon receipt at the laboratory, the temperature of all coolers will be measured using the temperature blanks to document proper sample preservation requirements.

Laboratory quality assurance samples (e.g., matrix spike (MS)/matrix spike duplicates (MSD); method blanks; laboratory control samples; and laboratory duplicates) will be prepared and analyzed by the laboratory. Results of the laboratory quality assurance samples will be reported with the original sample results. A narrative of any quality issues shall be included with the laboratory report from the lab.

The QAPP contained in **Appendix 4-D** (NewFields 2016) provides a detailed description of the QA samples and overall QA/QC program for this GMP.

3.7.2 Data Quality Review

Data quality reviews will be conducted on all data once finalized laboratory reports have been received. Results of data quality review will be documented on a Data Quality Review Sheet and reported with the associated laboratory reports. The objective of a data quality review is to ensure that data are collected and reported properly. A data quality review includes review of both field and laboratory analytical data.

3.7.2.1 Field Data Review

Field data to be reviewed include log books and sampling sheets (forms) to confirm that this SAP was followed, that data were properly entered and recorded (transcription/spelling errors), proper field/sampling procedures were used, and that there were no conditions that occurred that could affect reliability of the data. Results of the field data review will be summarized and included in the Annual Summary Report as described in Section 4.7 of NewFields (2016).

3.7.2.2 Laboratory Data Review

Procedures to validate laboratory data are derived from the EPA's Contract Laboratory Program, National Functional Guidelines for Organic Data Review (EPA 2008); and Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review (EPA 2013). Analytical reports will be checked to verify that holding times were met, proper matrix and units were reported, all requested analyses were conducted, and that proper analytical methods were used. Also, results of all laboratory internal QC samples (e.g., blanks, surrogate spikes, MS/MSDs, laboratory control samples, and target compound identification and quantitation) will be reviewed and evaluated to determine if results were within method acceptance limits.

The overall completeness of the data package will also be evaluated. Completeness checks will be administered on all data to determine whether deliverables are present. At a minimum, deliverables will include sample COC forms, analytical results, and QA/QC summaries. The reviewer will determine whether all required items are present and request copies of missing deliverables. In addition, any deficiencies in the lab reports requiring corrective action will be brought to the attention of the lab. Results of the data validation review will be summarized in a Data Validation Report for each sample report issued by the laboratory, and the reviewer shall certify if the data were collected in accordance with this SAP and is suitable for the intended use. The Data Validation Report will be appended to the Annual Summary Report described in Section 4.7 of NewFields (2016).

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EPA, see U.S. Environmental Protection Agency

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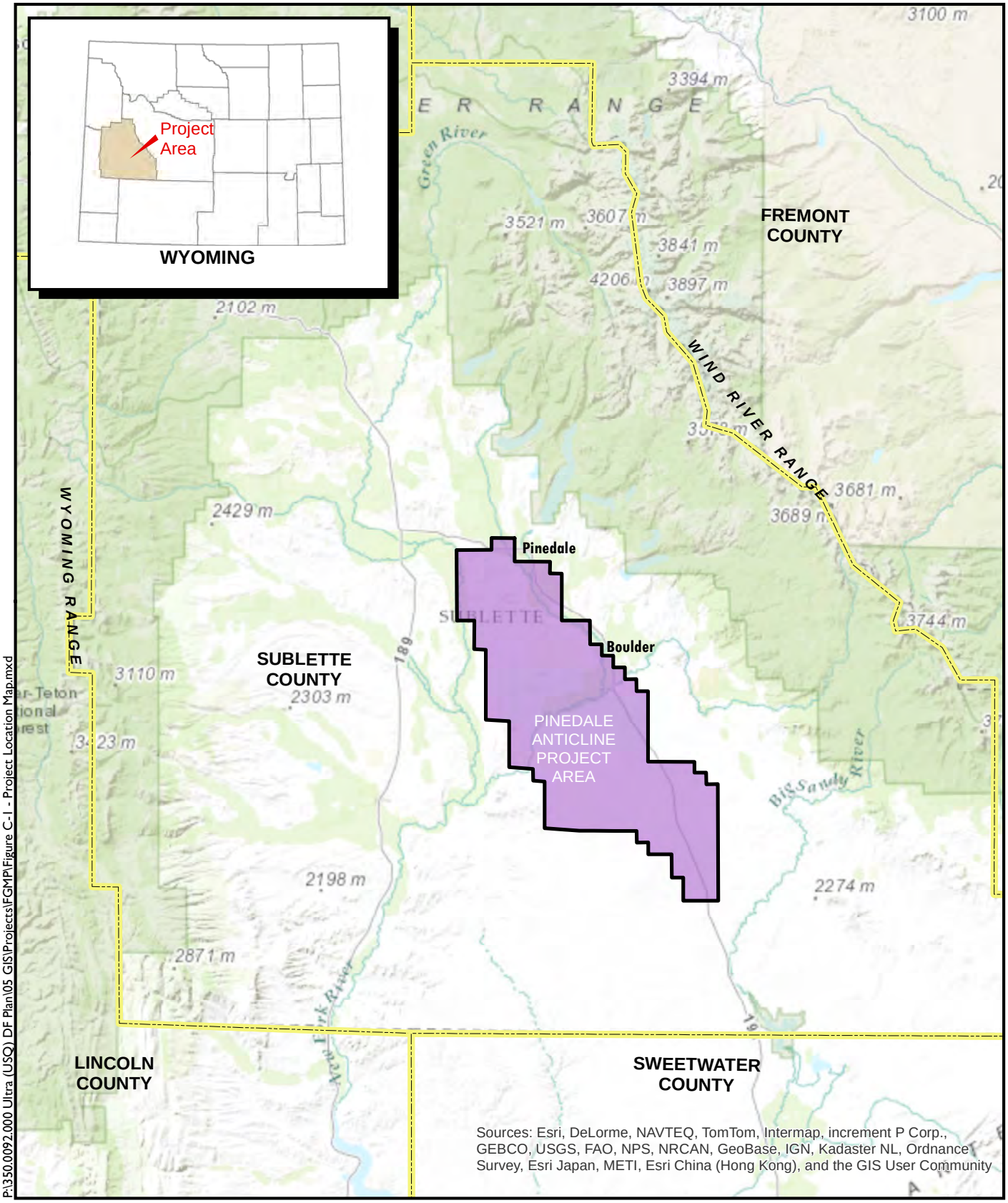
FIGURES

(FOR APPENDIX 4-C)



P:\350.0092.000 Ultra (USQ) DF Plan\05 GIS\Projects\FGMP\Figure C-1 - Project Location Map.mxd

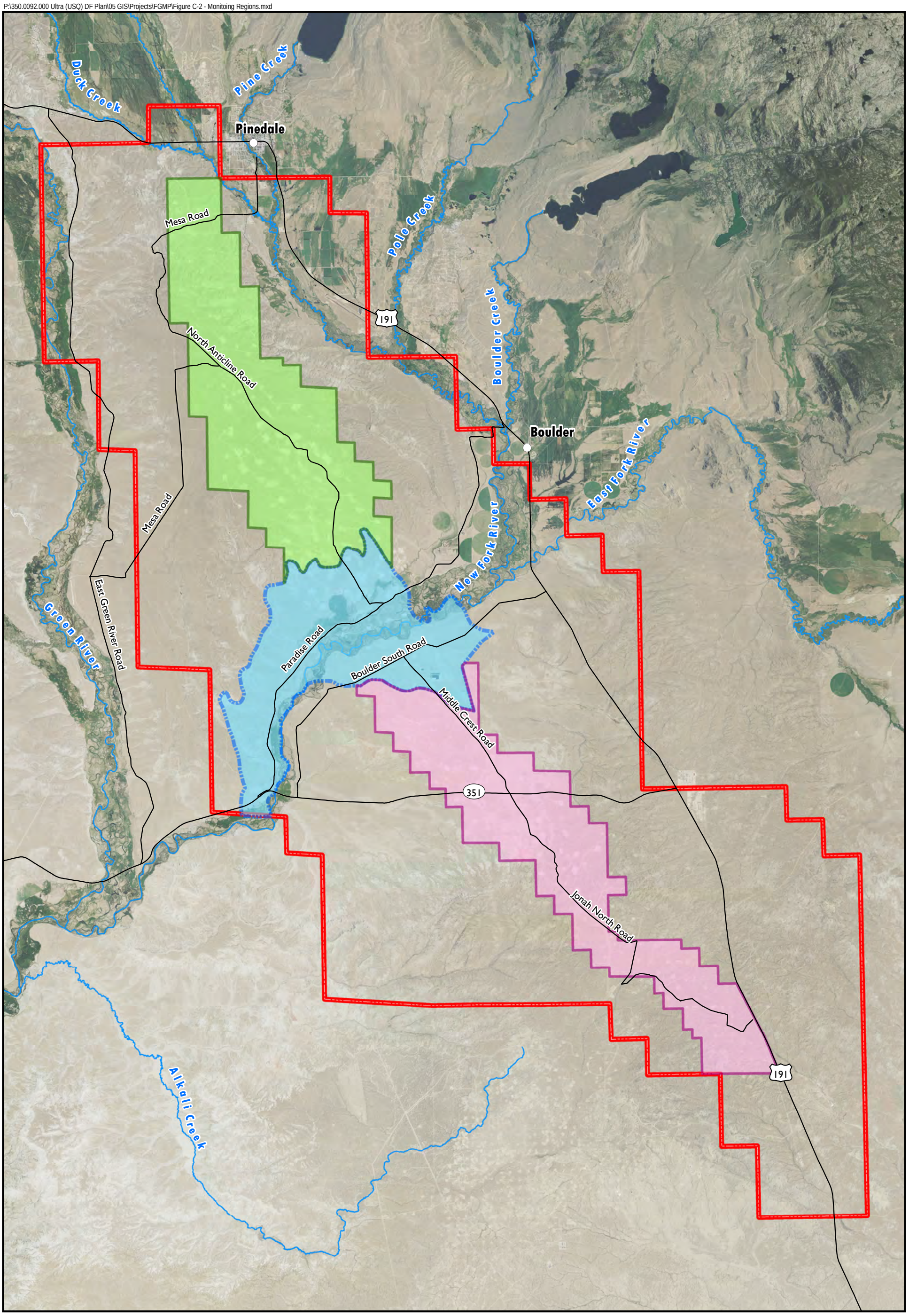
N

0 Miles 16

NewFields

Project Location Map
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4C-1

P:\350.0092.000 Ultra (USQ) DF Plan\05 GIS\Projects\FGMP\Figure C-2 - Monitoing Regions.mxd



Source: 2013 NRIS

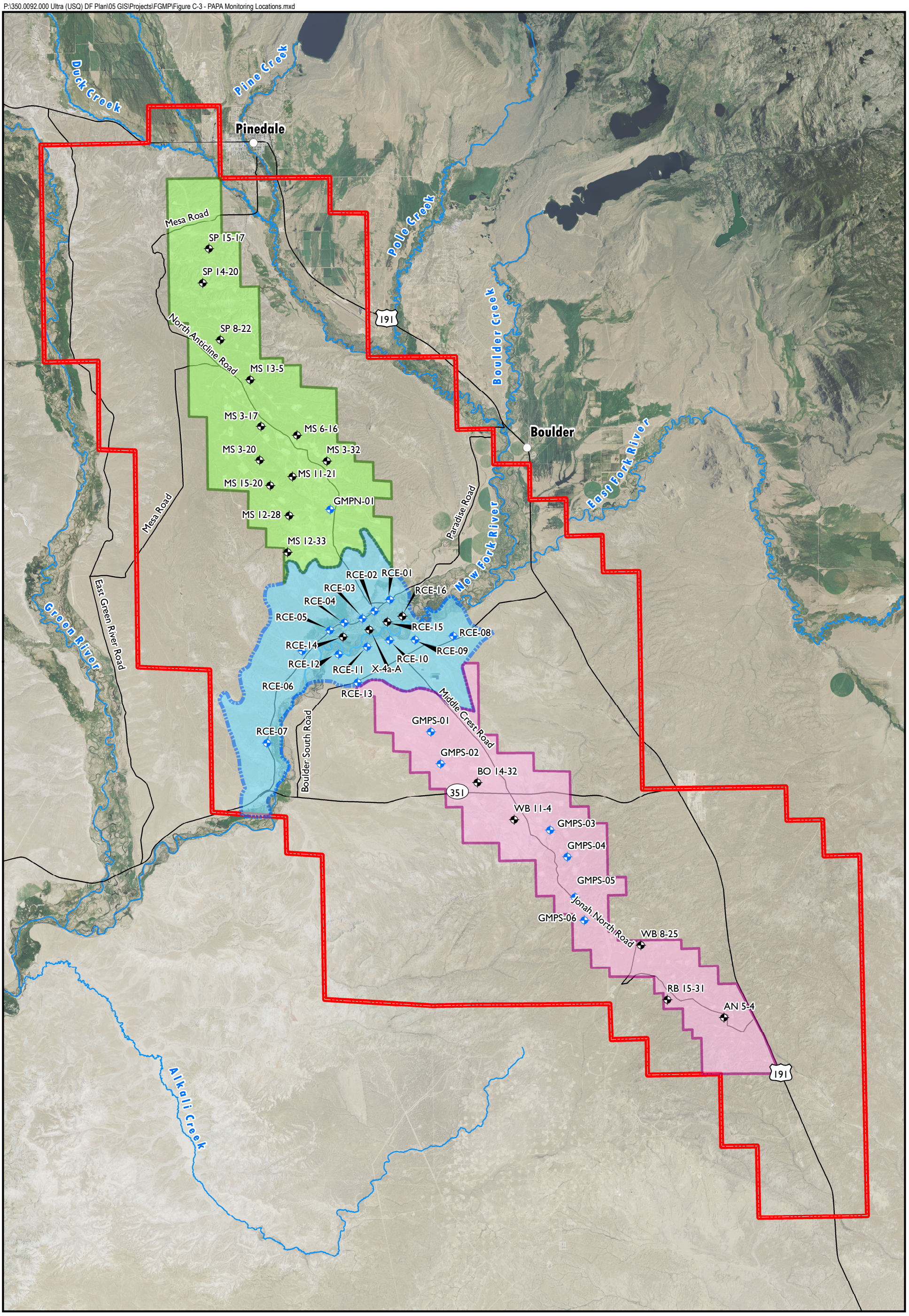
0 Miles 2.5

NewFields

North Zone
South Zone
River Corridor Envelope
Pinedale Anticline Project Area

Monitoring Regions
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4C-2

P:\350.0092.000 Ultra (USQ) DF Plan\05 GIS\Projects\FGMP\Figure C-3 - PAPA Monitoring Locations.mxd



Source: 2013 NRIS

N

0 Miles 2.5

NewFields

Monitoring Well

Industrial Water Supply Well

South Zone

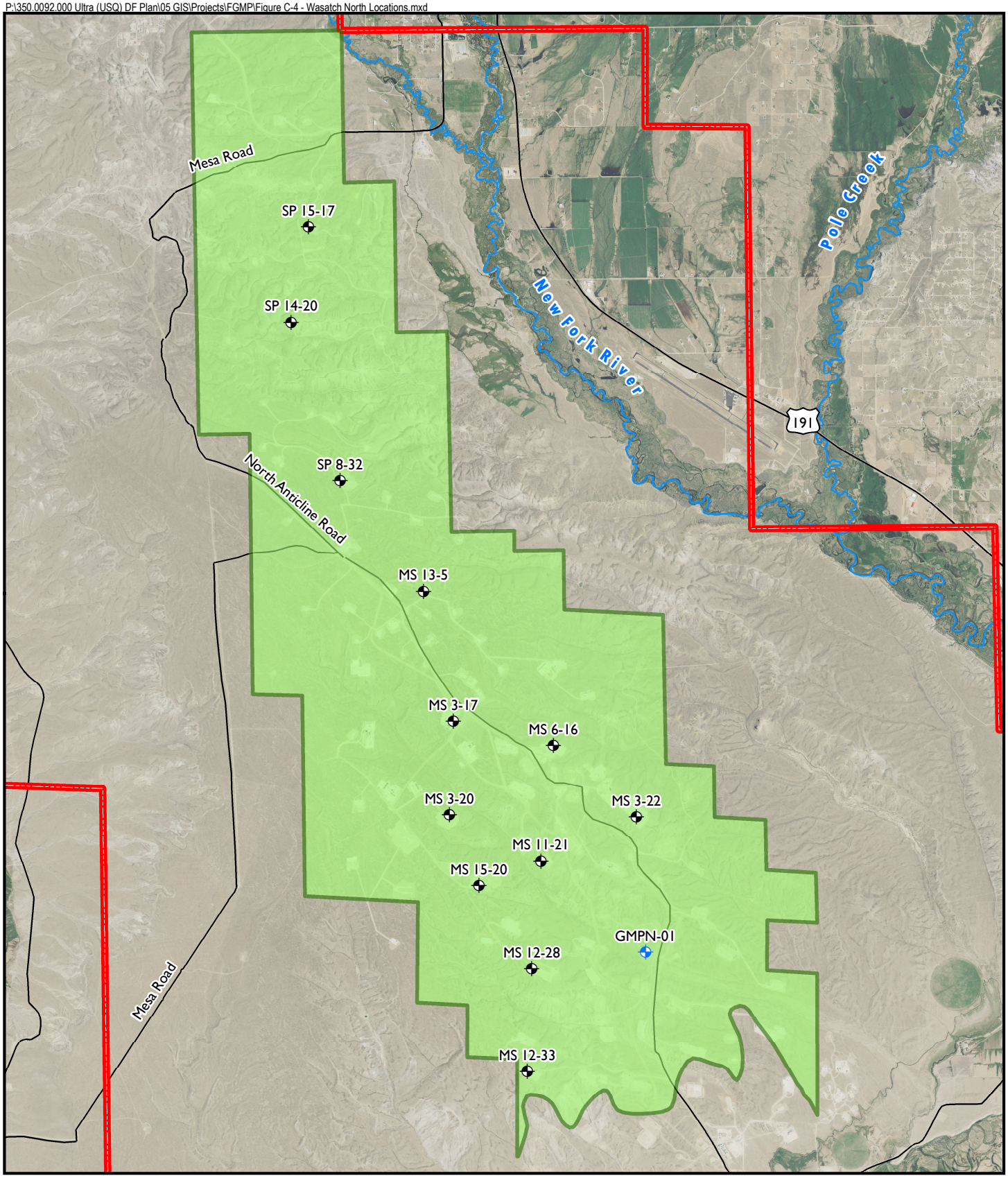
North Zone

River Cooridor Envelope

Pinedale Anticline Project Area

PAPA Groundwater Monitoring Locations
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4C-3

P:\350.0092.000 Ultra (USQ) DF Plan\05 GIS\Projects\FGMP\Figure C-4 - Wasatch North Locations.mxd



Source: 2013 NRIS

N

0 Feet 7,000

NewFields

Monitoring Well

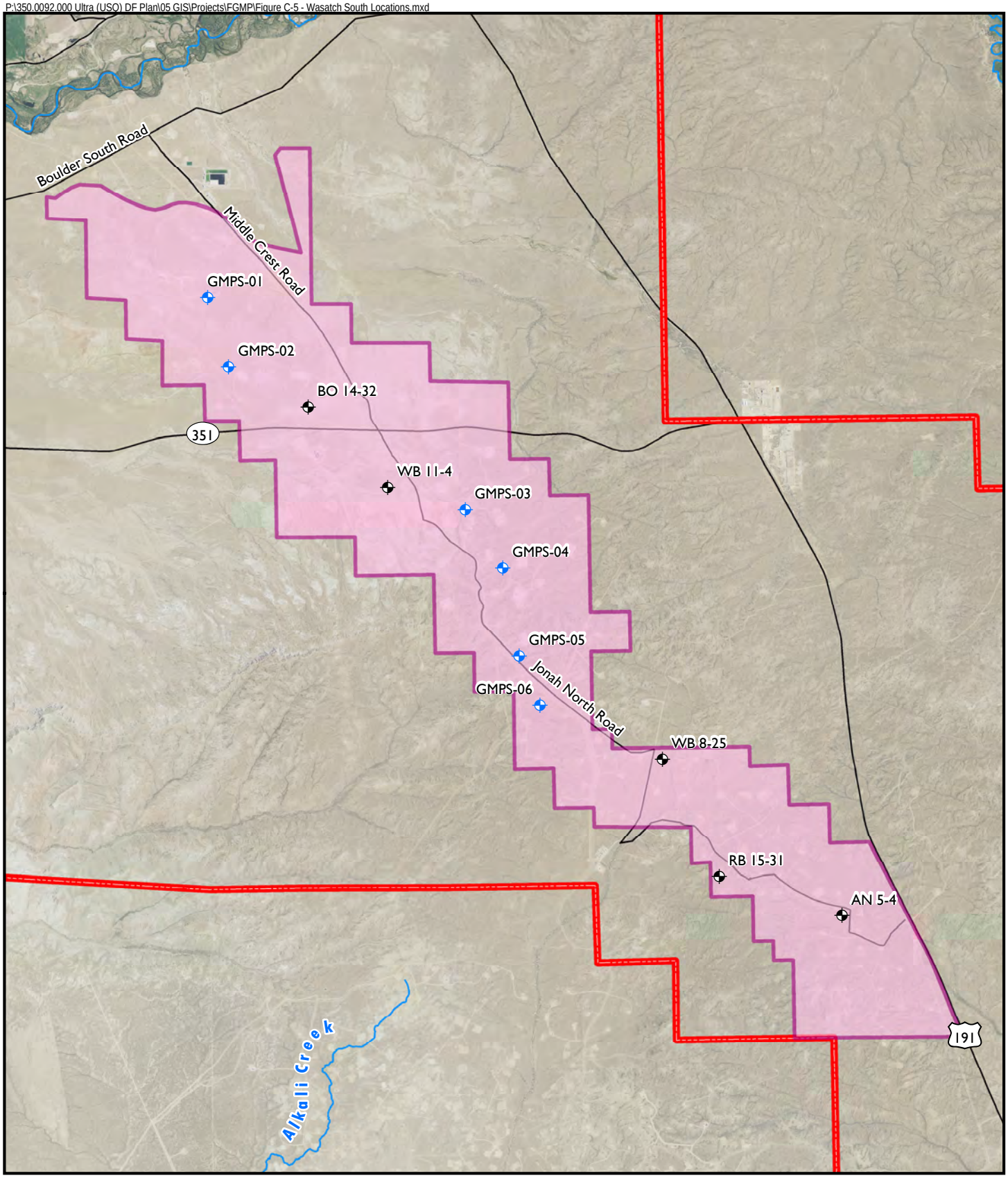
Industrial Water Supply Well

North Zone

Pinedale Anticline Project Area

Wasatch HSU Monitoring Locations, North Zone
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4C-4

P:\350.0092.000 Ultra (USO) DF Plan\05 GIS\Projects\FGMP\Figure C-5 - Wasatch South Locations.mxd



Source: 2013 NRIS

N

0 Feet 9,000

NewFields

Monitoring Well

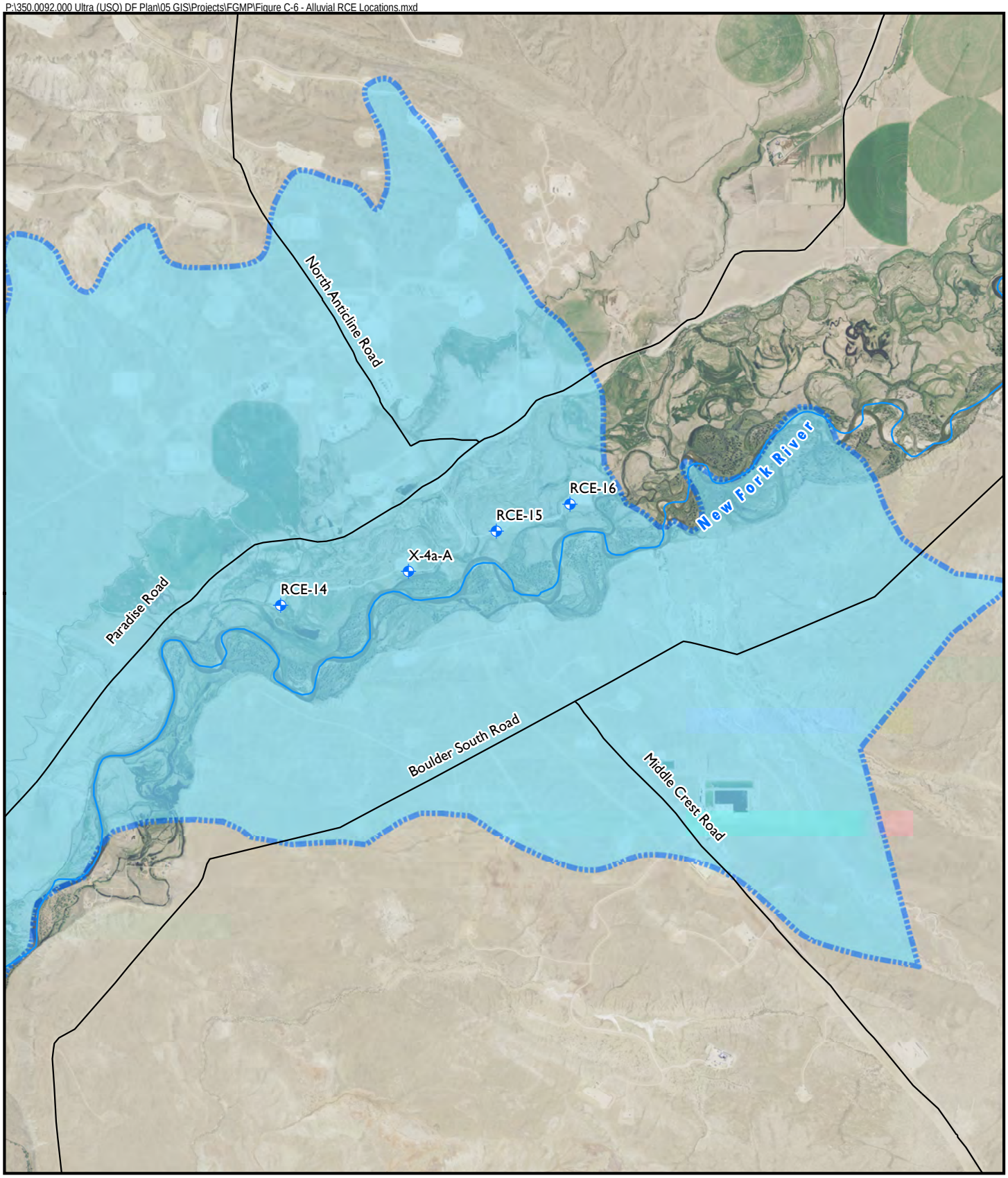
Industrial Water Supply Well

South Zone

Pinedale Anticline Project Area

Wasatch HSU Monitoring Locations, South Zone
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4C-5

P:\350.0092.000 Ultra (USO) DF Plan\05 GIS\Projects\FGMP\Figure C-6 - Alluvial RCE Locations.mxd



Source: 2013 NRIS

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0 Feet 4,000

Monitoring Well

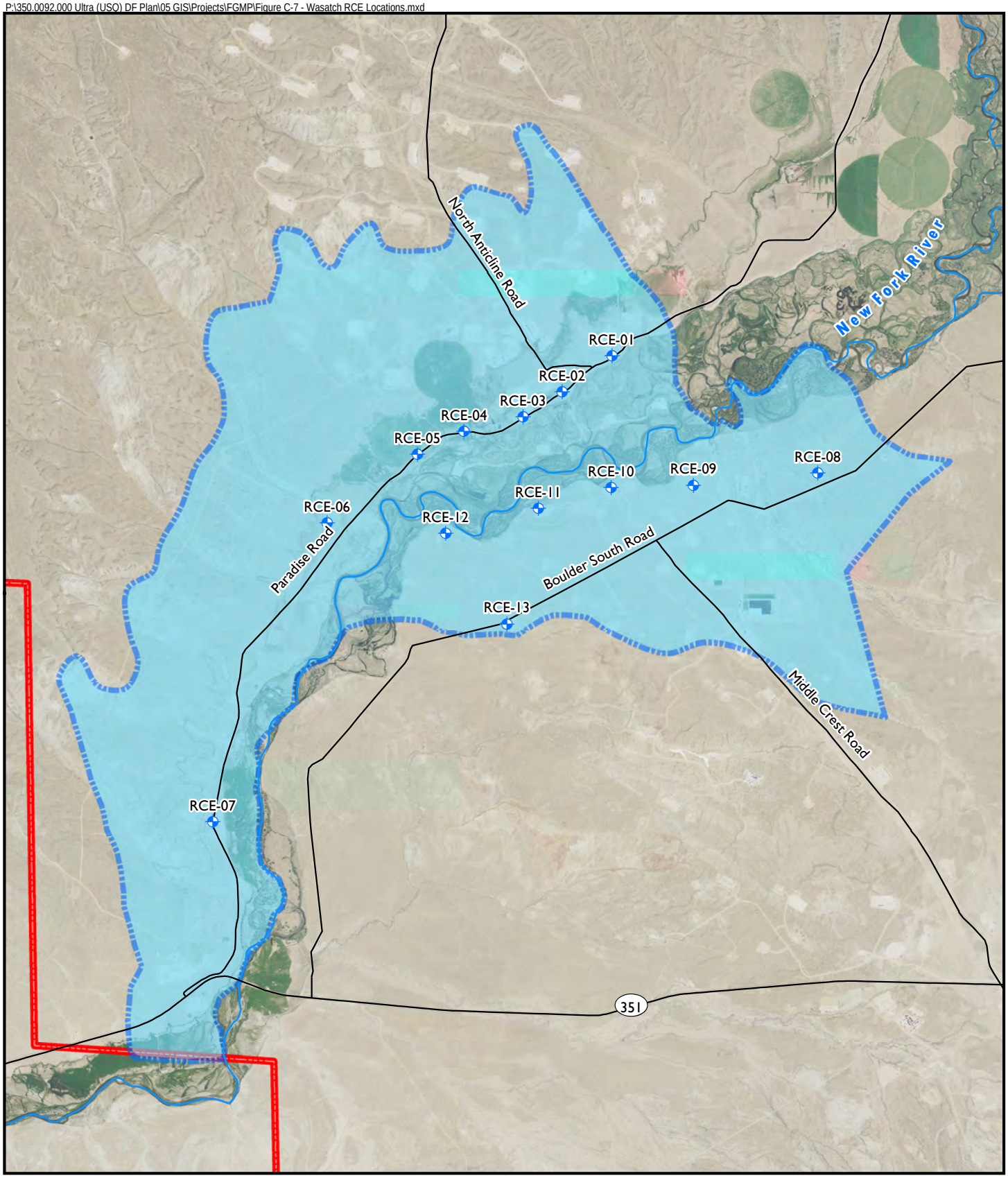
River Corridor Envelope

NewFields

Alluvial HSU Monitoring Locations in the River Corridor Envelope Pinedale Anticline Project Area Sublette County, Wyoming

FIGURE 4C-6

P:\350.0092.000 Ultra (USO) DF Plan\05 GIS\Projects\FGMP\Figure C-7 - Wasatch RCE Locations.mxd



Source: 2013 NRIS

N

0 Feet 6,000

Monitoring Well

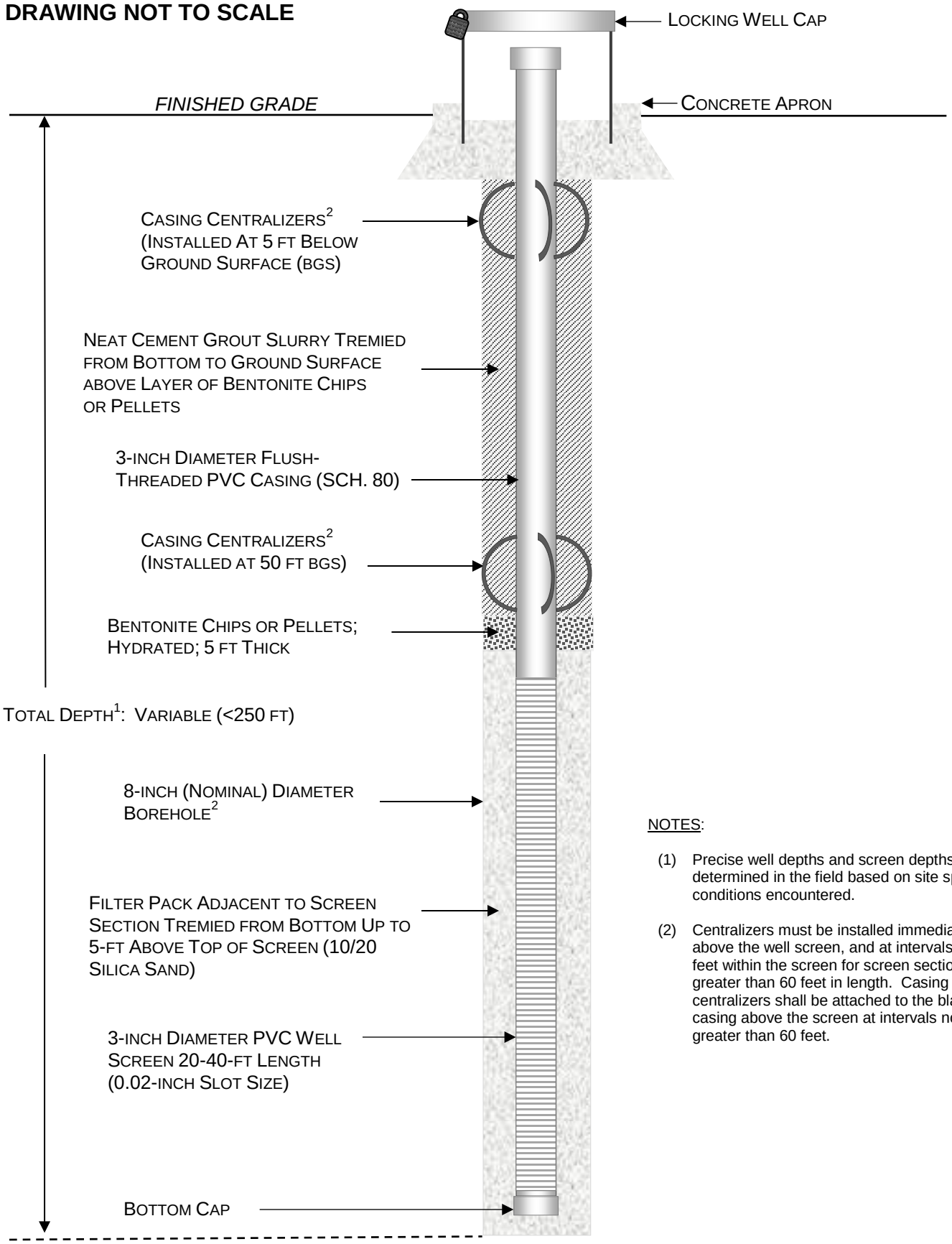
River Corridor Envelope

Pinedale Anticline Project Area

NewFields

Wasatch HSU Monitoring Locations
in the River Corridor Envelope
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 4C-7

DRAWING NOT TO SCALE



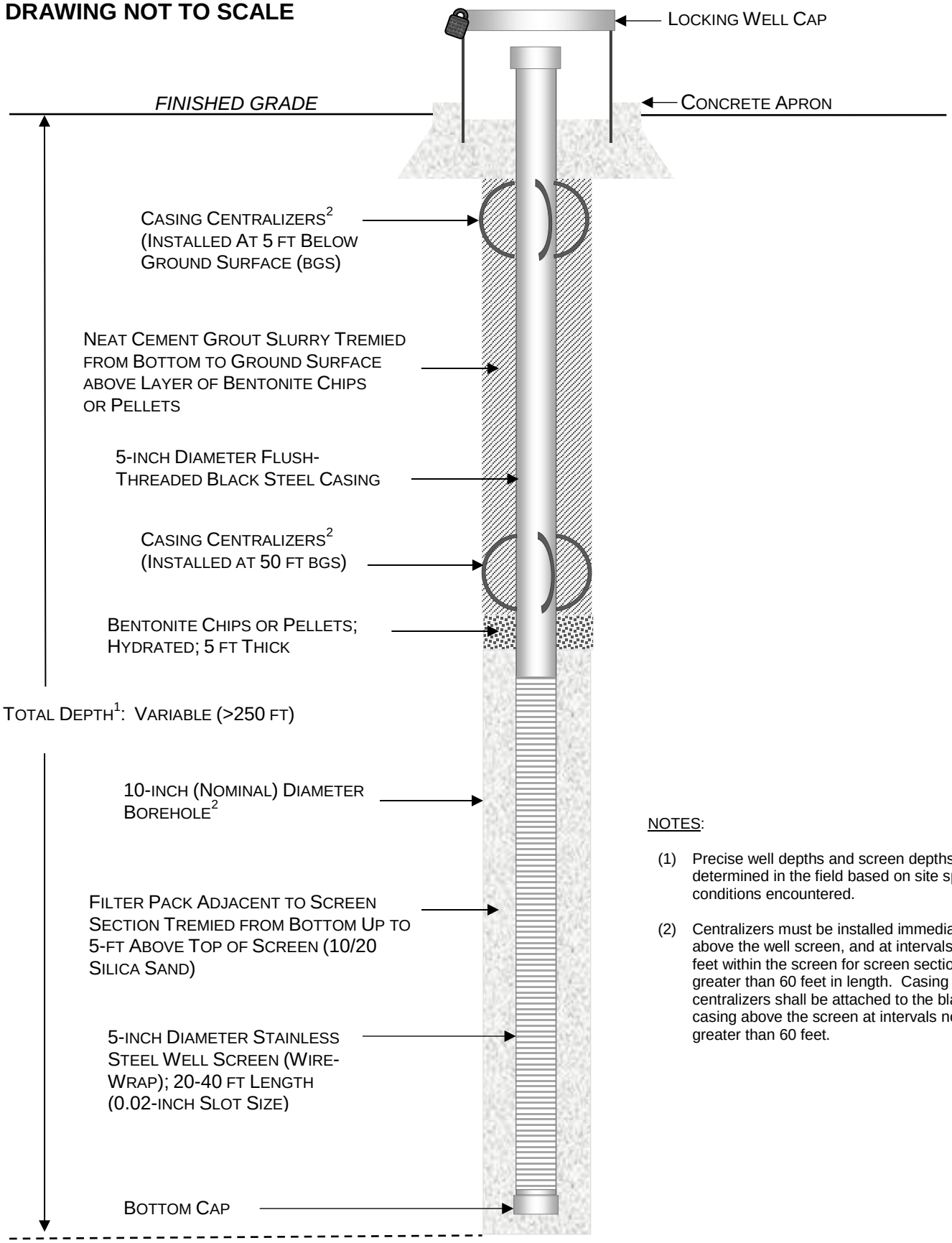
NOTES:

(1) Precise well depths and screen depths will be determined in the field based on site specific conditions encountered.

(2) Centralizers must be installed immediately above the well screen, and at intervals of 30 feet within the screen for screen sections greater than 60 feet in length. Casing centralizers shall be attached to the blank well casing above the screen at intervals not greater than 60 feet.

NewFields	GENERAL 3-INCH DIAMETER PVC MONITORING WELL CONSTRUCTION DETAILS	DATE: 12/02/2014
	Pinedale Anticline Project Area (PAPA), Wyoming	
	FIGURE C-8	PROJECT: 350.0092

DRAWING NOT TO SCALE



NOTES:

(1) Precise well depths and screen depths will be determined in the field based on site specific conditions encountered.

(2) Centralizers must be installed immediately above the well screen, and at intervals of 30 feet within the screen for screen sections greater than 60 feet in length. Casing centralizers shall be attached to the blank well casing above the screen at intervals not greater than 60 feet.

NewFields	GENERAL 5-INCH DIAMETER STEEL MONITORING WELL CONSTRUCTION DETAILS	DATE: 12/02/2014
	Pinedale Anticline Project Area (PAPA), Wyoming	
	FIGURE C-9	PROJECT: 350.0092