

Groundwater Monitoring Plan

TS Power Plant

Eureka County, Nevada



Prepared By:



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1. General

Newmont Nevada Energy Investment (NNEI) owns and operates the TS Power Plant (TSPP), located in Eureka County, Nevada. The TSPP is a 242 MW coal-fired power plant commissioned in 2008 and is one of the newest and most advanced coal fired power plants in the United States.

This groundwater monitoring plan has been developed to comply with requirements of Coal Combustion Residue (CCR) Rule (40 CFR, Part 257). Specifically the CCR Rule establishes a performance standard that states:

§257.91 The owner or operator of a CCR unit must install a groundwater monitoring system that consists of an adequate number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:

- (1) Accurately represent the quality of groundwater that has not been affected by leakage from a CCR unit....; and*
- (2) Accurately represent the quality of groundwater passing the waste boundary of the CCR unit.*

This groundwater monitoring plan describes: (1) the general conditions of the TS Power Plant CCR landfill; (2) the groundwater monitoring system that has been installed to detect and assess potential groundwater impacts from the CCR landfill; (3) the sampling and analysis procedures that are conducted as part of the monitoring program, and (4) statistical practices that will be followed to assess monitoring data.

2. Site Description

The primary fuel at TSPP is sub-bituminous coal from the Powder River Basin in Wyoming. The coal contains approximately 5.4% ash. At full load, the plant burns approximately 110 tons/hour (tph) of coal and generates about 5.9 tph of ash. Fly ash, the major component of CCR, is disposed of in the on-site ash landfill or transported off site for re-use as a cement substitute in concrete applications.

The TSPP facilities are located in the broad alluvial-filled Boulder Valley within Sections 11 and 14, Township 33N and Range 48E. The CCR landfill is located approximately 0.5 miles

northeast of the power plant. The CCR landfill is permitted as a Class III Landfill by Nevada Division of Environmental Protection – Bureau of Waste Management (Class III Permit SW270REV01). Under conditions of the permit, the landfill is allowed to accept three (3) non-hazardous waste streams: fly ash, bottom ash and water treatment filter cake.

The landfill is a fully geomembrane-lined facility (80-mil HDPE) with a total designed footprint of approximately 36 acres and a maximum CCR design height of 60 feet. During the operational life of the power plant, the CCR landfill will be constructed incrementally as six (6) adjoining, six (6)-acre cells plus two (2) storage ponds to contain run-off from the design storm event falling on the landfill. The individual cells are to be developed in stages on an as-needed basis to provide storage capacity for the planned life of the power plant facility.

Currently, two cells (Cell 1 and Cell 2) and one (1) pond (Pond 1) have been constructed (Figure 1). Cell 1, the southwestern cell of the landfill, was part of original plant construction and has operated from 2008 to present. Cell 2, an identical six (6) acre cell immediately north of Cell 1, was constructed in 2013 and is currently accepting the designated waste streams. Based on recent (2015) survey information, the landfill contains approximately 227,000 cubic yards of designated waste. This represents approximately 9% of the total design capacity. Cell 1 has approximately 20 feet of material placed and the placement of ash is progressing to the north into Cell 2. Currently, Cell 2 has very little material on it. The disposal of CCR on the landfill is well below original projections, since the majority of fly ash being generated by TSPP is shipped offsite for re-use as a cement substitute.

3. Groundwater Monitoring System

The groundwater monitoring system has been designed to reflect local groundwater hydrology and ensure that monitoring wells are properly located to accomplish the requirement to detect and assess any potential impacts to groundwater resulting from operation and closure of the CCR landfill. Initial geotechnical evaluations of the area were conducted by AMEC as part of TSPP permitting and are incorporated in the Class III Landfill Permit Application¹ submitted to NDEP – Bureau of Waste (NDEP-BWM).

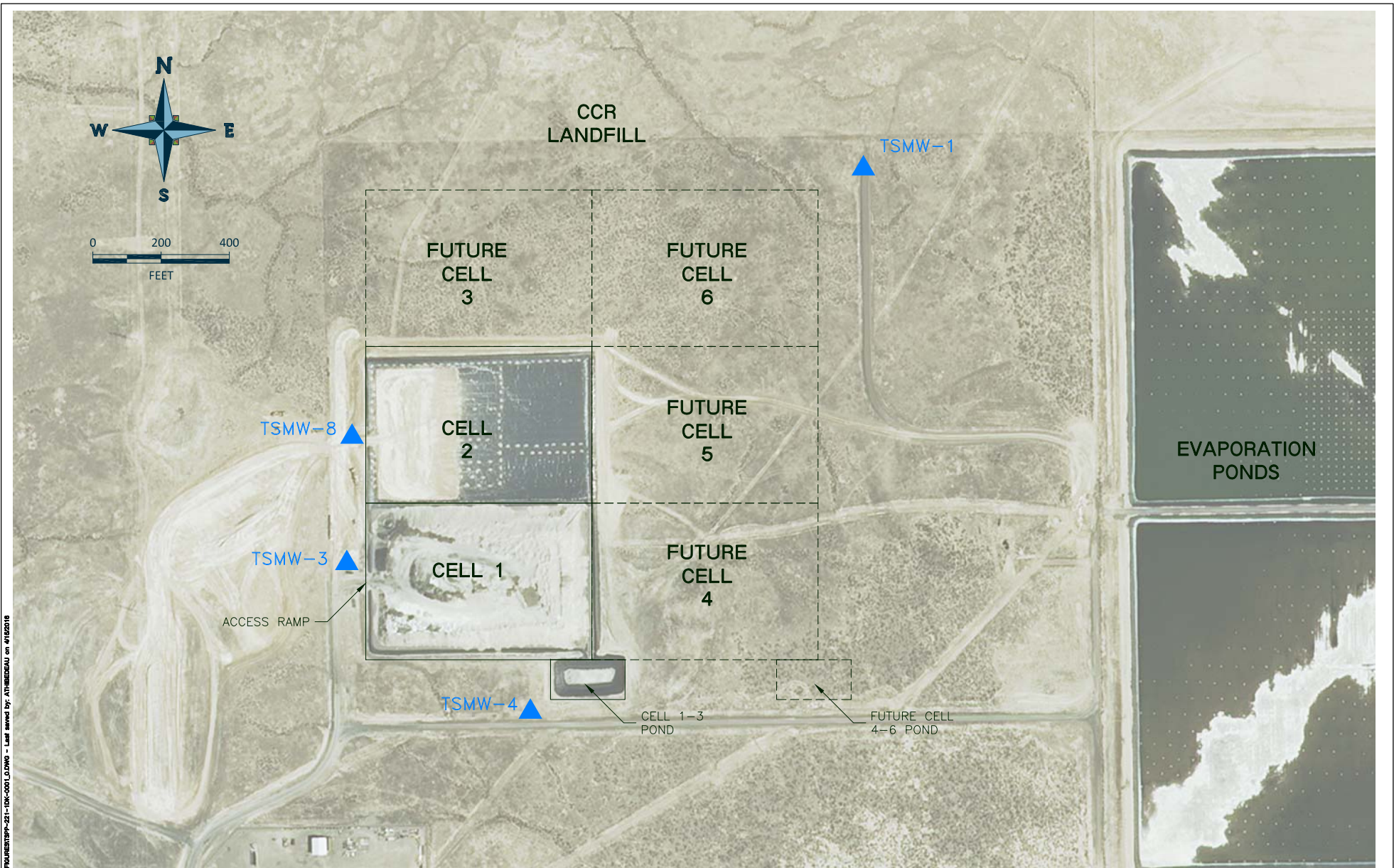
¹ 2005, Revised Class III Landfill Application, TS Power Plant, Eureka County, Nevada, March 2005, submitted by AMEC Earth and Environmental, Inc.

This initial evaluation consisted of reviewing prior geophysical data and installing several test borings with temporary piezometers in the footprint of the proposed landfill. Based on a prior gravimetric survey, it was determined that the thickness of saturated alluvium in the area is at least 1,000 feet. Depth to groundwater in proximity to the landfill site was 17 to 36 feet below ground surface. Data indicated a very shallow gradient of 0.00086 ft/ft to the southwest. Lithologic units encountered in the area consisted of silt to gravel. Hydraulic conductivity of these materials may be quite variable and could range from 1×10^{-2} cm/sec to 1×10^{-5} cm/sec. Based on available data, the average rate of groundwater flow was conservatively estimated at 81 ft/yr.


Based on the geotechnical investigation and the landfill footprint, a groundwater monitoring system consisting of three (3) monitor wells; one upgradient and two downgradient was proposed in the landfill application. NDEP-BWM accepted the monitoring system design, which was incorporated in the Class III Landfill Permit issued in 2005. Consistent with conditions of the permit, a groundwater monitoring system consisting of the following monitoring wells was constructed (refer to Figure 1):


- TSMW-1 is located approximately 2,000 feet northeast of Cell 1. It is an upgradient well constructed to establish background groundwater chemistry. TSMW-1 has been monitored since 4th Quarter, 2005.
- TSMW-3 is a downgradient well located immediately west of Cell 1. TSMW-3 has been monitored since 1st Quarter, 2008.
- TSMW-4 is a downgradient well located south of Cell 1, adjacent to the Cell 1 collection pond. TSMW-4 has been monitored since 1st Quarter, 2008.

The CCR Rule requires that a groundwater monitoring system for an existing CCR landfill consist of a minimum of one upgradient and three downgradient wells (§257.91(c)(1)). To comply with this requirement, an additional downgradient monitor well (TSMW-8) was installed in 2015. The well is located immediately west of Cell 2. TSMW-8 has been monitored since 4th Quarter, 2015. The location of the monitor wells is indicated on Figure 1. A summary of monitor well locations, depth and depth to water is included as Table 1. Based on calculations for groundwater gradient and flow rate, the location of the monitor wells relative to the landfill are such that any impacts to groundwater would be detected in a timely manner.



NOTE:
 PHOTO DATE: AUGUST 2013. SOURCE: NAIP

KEY:
 MONITORING WELL

		AREA	TS POWER PLANT	CLIENT	NEWMONT
		PROJECT	CCR LANDFILL		
PROJECT NUMBER	LOCATION	FIGURE TITLE			
475.0221	EUREKA COUNTY, NEVADA	GROUNDWATER MONITORING WELLS			
DOCUMENT FILENAME	TSP-221-1DK-0001_0.DWG	FIGURE NUMBER	1	REVISION	0



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Design of all monitor wells were approved by the Nevada Division of Water Resources and comply with Nevada regulations regarding monitor well construction. As an example of typical well construction, the as-built construction drawing for TSMW-8 is included as Figure 2. Construction drawings for all monitor wells are maintained in the landfill operating record.

Table 1 - TS Power Plant CCR Landfill Groundwater Monitor Wells

Well No.	Coordinates ¹	Elevation (amsl)	Depth (ft)	Depth to Water (ft) ²	Water Elevation	Completion	Type
TSMW-1	462,246.4 N 493,250.4 E	4644.34	55	29.5	4614.84	2005	Upgradient - Background
TSMW-3	461,097.1 N 491,724.9 E	4651.5	50	39.3	4612.2	2007	Downgradient
TSMW-4	460,662 N 492,251.5 E	4642.12	60	29.2	4612.92	2007	Downgradient
TSMW-8	461,426.2 N 491,731.9 E	4651.89	58	39.2	4612.69	2015	Downgradient

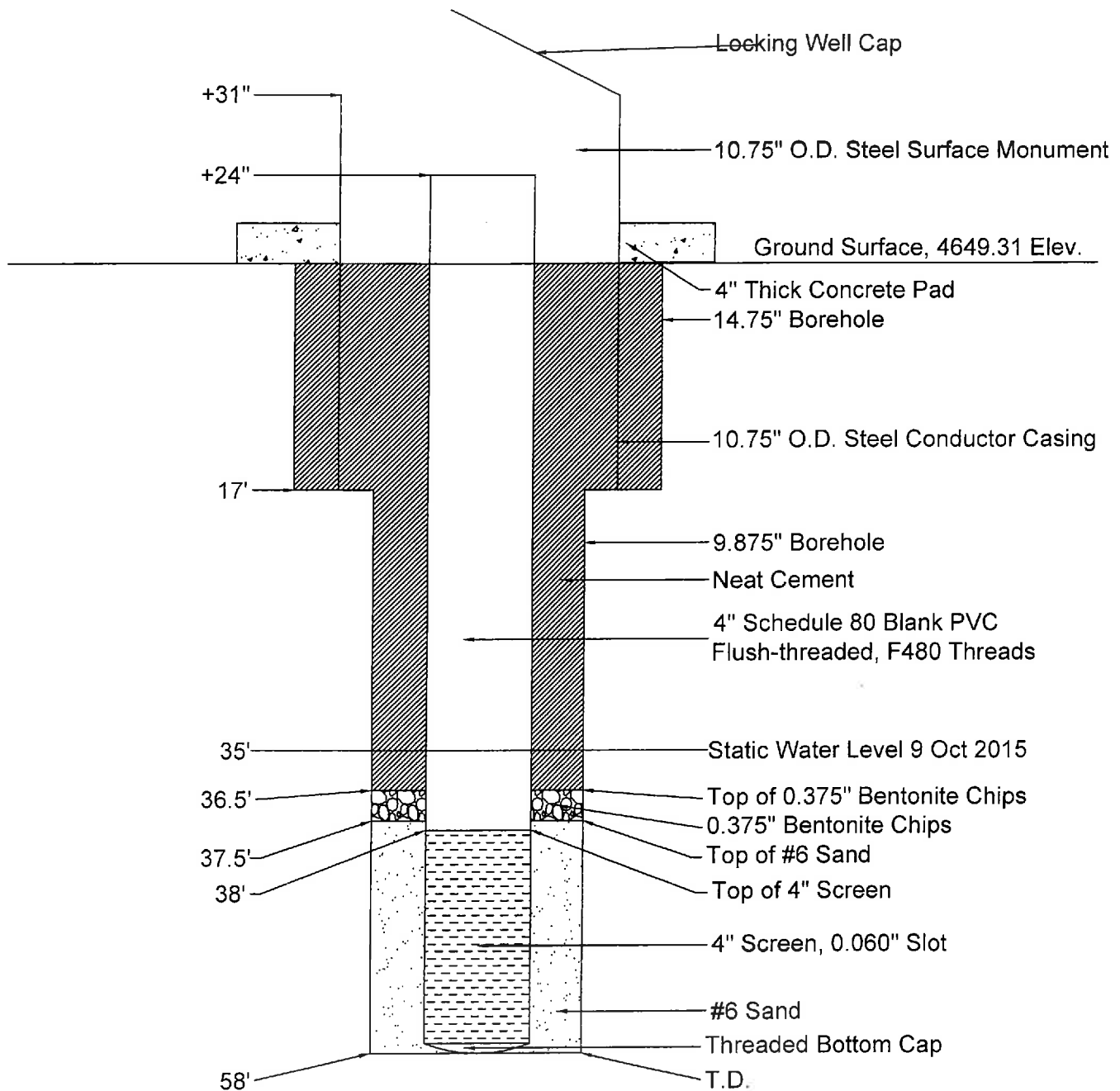
Notes: 1 - local coordinate system
2 -22 Oct, 2015 measurement

The groundwater monitoring system includes the minimum number of wells required by the CCR rule. Considering the design and footprint (12 acres) of the existing CCR landfill and the local groundwater hydrology, the monitoring system is sufficient to demonstrate compliance with the CCR performance standard. If expansion of the CCR landfill occurs in the future, the groundwater monitoring system will be re-evaluated to determine if additional groundwater monitoring wells are warranted.

4. Groundwater Monitoring

Groundwater monitoring is conducted in accordance with the requirements of Class III Permit SW270REV01 and the CCR Rule. The combination of requirements involves groundwater monitoring for three suites of analytes (Table 2):

Permit SW270REV01 - Groundwater samples are tested for the following constituents: total dissolved solids, pH, conductivity, arsenic, barium, beryllium, cadmium, lead, nickel, selenium, silver and total organic carbon. Quarterly monitoring under conditions of the landfill permit has been conducted since: 2005 for TSMW-1; 2008 for TSMW-3 and 4; and 2015 for



NOT TO SCALE

FIGURE 2



TS Power Plant
Lander County, NV

Monitor Well TSMW-8
As-built

SW 1/4 NE 1/4 Section 11 T39N R48E
40.75272 N, 116.52773 W, 4649.31 AMSL

COMPUTER GENERATED DRAWING NO MANUAL REVISIONS ALLOWED

DWG SCALE	PLOT SCALE	ACAD FILE NAME	NGC DRAWING NUMBER	REV
NONE	NONE	TSPM Monitor Wells		0
REV. DATE	PLOT DATE	JOB No.		
10/21/15	10/21/15			

TSMW-8. Monitoring data is reported to NDEP-BWM as part of a semi-annual landfill report. Historical data is archived in the landfill operating record.

CCR Detection Monitoring (§257.94) - The CCR rule prescribes requirements for a Detection Monitoring Program that must be conducted through the active life of a CCR landfill and the post-closure period. Analytes associated with the Detection Monitoring program are specified in §257, Appendix III and listed in Table 2. The CCR Rule requires semi-annual detection monitoring; however, for consistency with the existing monitoring program, detection monitoring is conducted on a quarterly basis. Detection monitoring of all monitor wells began in 4th Quarter, 2015. As an initial phase of detection monitoring, there is a requirement that eight (8) independent samples from each monitoring well be collected and analyzed for the detection monitoring constituents prior to October 17, 2017 (§257.94(b)).

CCR Assessment Monitoring (§257.95) - The CCR rule prescribes requirements for an Assessment Monitoring Program that must be established if detection monitoring demonstrates a statistically significant increase over background levels for one or more constituents. Analytes associated with the Assessment Monitoring program are specified in §257, Appendix IV and listed in Table 2. In order to establish background levels, there is also a requirement that eight (8) independent samples from each monitoring well be collected and analyzed for the assessment monitoring constituents prior to October 17, 2017 (§257.94(b)). As indicated in Table 2, due to an overlap of requirements, a number of assessment monitoring constituents are monitored as part of the landfill permit monitoring program and have been monitored since 2008. Assessment monitoring for the remaining constituents has been conducted since 4th Quarter, 2015.

Table 2 - TS Power Plant Ash Landfill - Groundwater Monitoring Constituents and History

Constituent	Landfill Permit Requirement ¹	CCR Detection Monitoring ²	CCR Assessment Monitoring ³	Quarterly Monitoring Start
Depth to Water	X			2008
Arsenic	X		X	2008
Barium	X		X	2008
Beryllium	X		X	2008
Cadmium	X		X	2008
Chromium	X		X	2008
Lead	X		X	2008
Nickel	X			2008
Selenium	X		X	2008
Silver	X			2008
Total Organic Carbon	X			2008
pH	X	X		2008
TDS	X	X		2008
Spec. Conductivity	X			2008
Mercury	X		X	2008
Boron		X		2015
Calcium		X		2015
Chloride		X		2015
Fluoride		X	X	2015
Sulfate		X		2015
Antimony			X	2015
Cobalt			X	2015
Lithium			X	2015
Molybdenum			X	2015
Thallium			X	2015
Radium 226/228			X	2015
1 - Class III Permit SW270REV01 2 - 40 CFR Part 257, Appendix III 3 - 40 CFR Part 257, Appendix IV				

4.1. Sampling Procedures

Monitor well sampling will be conducted by experienced technicians from Newmont Mining Corporation’s hydrology department. Procedures associated with sampling of permit compliance points will be consistent with those currently in use at other compliance monitoring points at Newmont Mining Corporation. Samples will be handled in accordance with EPA standards.

A copy of the TSPP's *Water Sampling and Monitoring Procedures* (March 2010) is included as Attachment A to this plan. This procedure manual contains detailed documentation regarding the collection and recording of field data, calibration of instrumentation, collection and preservation of groundwater samples, quality control and chain of custody procedures. Analysis will be conducted at a Nevada certified laboratory using approved EPA methods.

5. Monitoring Data Analysis

5.1. Evaluation of Waste Streams

The TSPP Ash Landfill accepts three waste streams: fly ash, bottom ash and water treatment filter cake. Coal combustion residue represents the largest component, representing about 95% of total disposed waste. In order to identify potential groundwater impacts from the landfill, these waste streams have been characterized in terms of chemistry of leachates. The characterization was conducted by quarterly analysis of fly ash samples using the Synthetic Precipitation Leach Procedure (SPLP) and the water treatment waste using a TCLP analysis. Data is summarized in Table 3.

As indicated, leachate samples in CCR were consistently below detection limits for several analytes including: antimony, beryllium, cadmium, copper, lead, nickel, silver, thallium and zinc. Detectable concentrations were identified for the following metals: arsenic, barium, chromium, selenium, and mercury.

This waste characterization indicates that the primary characteristic of any potential leachate from the ash landfill would be high pH (>10.5), elevated TDS, and detectable barium, chromium and selenium.

Table 3 - Characterization of Waste Streams - TS Power Plant Ash Landfill

TS Power Plant - Fly Ash		
<i>Analyte</i>	<i>Total (mg/kg)¹</i>	<i>SPLP (mg/kg)²</i>
Antimony	<2.0	<0.003
Arsenic	19.3	<0.003 - 0.54
Barium	603.0	0.388 - 6.93
Beryllium	2.16	<0.002
Cadmium	0.33	<0.002
Chromium	49.2	0.069 - 0.209
Copper	111	<0.01
Lead	21.7	<0.003
Nickel	37.25	<0.01
Selenium	12.1	0.0125 -0.0263
Silver	0.8	<0.005
Thallium	3.2	<0.001
Zinc	83.7	<0.02
Mercury	0.94	<0.0002 - 0.0003
pH		10.8 - 12.28
TDS		650 - 1400
1 - Sample Date: 2012		
2 - Range of analytical values (2008-2012)		

TS Power Plant - Water Treatment Sludge		
<i>Analyte</i>	<i>Total (mg/kg)¹</i>	<i>TCLP (mg/kg)²</i>
Antimony	<2.0	
Arsenic	12.2	<0.05
Beryllium	1.82	
Cadmium	0.73	<0.01
Chromium	43.6	0.219
Copper	95.7	
Lead	19.3	<0.05
Nickel	28.5	
Selenium	8.2	<0.05
Silver	0.83	<0.05
Thallium	3.6	
Zinc	88.6	
Mercury	0.625	<0.0002 - 0.0042
Barium		<1.00 - 1.26
1 - Sample Date: 2011		
2 - Range of analytical values (2009-2011)		

5.2. Statistical Evaluation of Groundwater Data

As part of the ongoing groundwater monitoring program, measured concentrations of groundwater constituents will be evaluated against the upper background limit values (UBL) computed using a dataset of existing groundwater data. The UBL are calculated as the 95th upper tolerance limit with 95% coverage. In other words, this value represents an upper limit below which 95% of future measured concentrations will be occur with a 95% statistical confidence. In calculating the UBL, statistical methods specific to the identified underlying population distribution of the data being analyzed are used. Where no underlying population distribution can be identified a suitable non- parametric statistical method is utilized for analysis. In order to calculate UBL values, a minimum of eight (8) data points are required in the dataset. The USEPA has developed the ProUCL software package that will be used for the statistical analysis. ProUCL is now the industry standard for the determination of UBLs for environmental background data.

Prior to determining background concentration values, the dataset is examined using various statistical methods in order to validate underlying statistical assumptions. Specifically, the dataset must meet the following criteria:

- Data independence – Each measured concentration is independent of other measurements in the same dataset.
- Temporal Stationarity – The statistical properties of the dataset, including its mean and standard deviation, should not exhibit secular (increasing or decreasing) temporal trends (trends of time).
- Pooling – The datasets between wells are examined to determine if statistical properties are similar and pooling of data between wells is appropriate.

The existing TSPP groundwater monitoring datasets have been evaluated by statistical experts from Newfields to determine UBLs. Attachment B is a technical memorandum documenting the statistical evaluation and includes the calculated UBLs for the existing data. At the current time, adequate monitoring data (a minimum of eight sample points) is not available for all constituents required under the CCR rule. When adequate data is available (4th Quarter, 2017) the statistical evaluation will be updated and UBLs will be determined for the complete dataset.

To provide a visual representation of future sampled data and the calculated UBL, a chart similar to a control chart will be utilized with the upper limit represented by the calculated UBL. This visual representation will be incorporated with the annual Groundwater Monitoring and Corrective Action Report required under §257.90(e). The initial annual monitoring report will be prepared and uploaded to the TSPP CCR website prior to January 18, 2018.

Any future measured groundwater concentrations above the UBL indicates a potential change in groundwater quality possibly resulting from current activities. Evaluation of future measured concentrations against background will be based on the following approach:

- An initial observed exceedance in groundwater concentration above the UBL potentially represents a statistically significant increase in concentrations above background. However, this initial exceedance will not result in any action beyond continued monitoring of the sample location.
- If the sample location continues to exceed the UBL for three consecutive sampling periods then an assessment monitoring program (§257.95) will be instituted and if necessary a corrective action plan will be designed and implemented. Notification that an assessment monitoring program has been established will be made in accordance with §257.106.

6. Recordkeeping

All groundwater monitoring data and associated information will be maintained in the landfill operating record in accordance with §257.105. This will include:

1. Monitoring field data, analytical reports, monitoring data spreadsheets and control chart analyses,
2. Documentation concerning any modifications to the groundwater monitoring system and monitoring equipment,
3. Groundwater system certifications,
4. Selection of statistical method certification,
5. Notifications to regulatory agencies

ATTACHMENT A
Water Sampling & Monitoring Procedures (March 2010)

NEWMONT NEVADA ENERGY INVESTMENT

TS POWER PLANT

**Water Sampling
and
Monitoring Procedures**

March 2010

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Appendix A - Instrument Calibration and Use

Appendix B - Recommendations for Sampling and Preservation of Waters

Appendix C - Well Purging Calculation

Appendix D - Chain of Custody Record

1. INTRODUCTION

The following are the monitoring procedures, water sampling protocol and QA/QC practices for the TS Power Plant (TSPP). Included are standard operating procedures (SOP's) for using various types of purging/sampling systems and other information to assist technicians while performing sampling and managing the resulting data. Revisions to this document will be made to reflect changes to TSPP's water monitoring program or EPA guidance.

Accurate water quality data are critical to ensure permit compliance and demonstrate that water resources are not impacted by operations. The generation of reliable data begins with the collection of the sample. Adherence to the SOP's will ensure that samples are representative, and collected in accordance with standard water sampling methods and QA/QC protocols. To produce data of defensible quality, this quality control program will be strictly adhered to during sample collection.

The water-sampling program includes collecting samples, recording field data, submitting samples for analysis and reviewing analytical results.

2. SAMPLER DUTIES

Collection of reliable water data and maintenance of analytical data are the foundation of water-related compliance activities. Thus, the duties performed by the sampler provide one of the most critical elements of the Environmental Department's efforts. Although this document primarily is focused on sample collection and handling methods, the generation of water data can be envisioned as a loop that includes more than simply sample collection. For any given sample, the sampler's duties have not been completed until this loop is closed. In general a complete loop includes the collection of the sample, transmittal of the sample to a lab and the receipt, review and storage of analytical data.

2.1. Tasks

Each of these steps includes several tasks, each of which must be conducted in accordance with the procedures outlined in this document. Specific duties include the following:

- Collection of samples;
- Collection of duplicate and control samples;
- Collection of field data;
- Maintenance of equipment;
- Calibration of equipment used to collect field data;
- Tracking sample status;
- Data review and management;
- Updating sample schedules, maps and other documents as needed;
- Conducting periodic inventory of equipment;

2.2. *Site Inspection*

The primary function of a sampler is to collect samples. In the performance of this task one often visits a large portion of particular properties. Samplers should strive to be observant of environmental conditions while in the field and should be aware of circumstances or occurrences, which are unusual or different from past events. Leaks or damp areas, materials stored in possibly unauthorized places, wildlife in the vicinity of ponds or livestock in active operational areas are examples of things to be noted. Any concerns noted should be promptly brought to the attention of the site environmental manager.

3. **FIELD QUALITY CONTROL**

The TSPP quality control program consists of the following elements: sampler competence, utilization of standards, field blanks and duplicates, calibration of meters, equipment maintenance and routine auditing of sampling procedures. Analytical results of control samples (i.e. blanks and duplicates), will not be used to modify any sample analyses reports.

3.1. *Sampler Competence*

TSPP are members of the Newmont environmental monitoring group. Samplers are trained by department personnel who are knowledgeable and experienced in Newmont's monitoring program.

3.2. *Calibration*

All calibration and calibration check data will be documented in the field log book. All field equipment will be calibrated prior to field use. Calibration procedures shall follow manufacturers' specifications. A calibration check will be performed after all samples have been collected for the day. Calibration checks will not be used to correct pH readings taken during the day.

3.3. *Trip Blanks*

Newmont utilizes trip blanks (control samples) to insure no environmental contamination, and to provide a check of analytical laboratory performance. To collect a trip blank, fill sample bottles with deionized water. Preserve the samples and send to the analytical laboratory. The analyses requested will be identical to the other samples being analyzed. A trip blank sample will be taken on a quarterly basis.

3.4. *Duplicate Samples*

Duplicate samples are two or more samples collected at the same time from the same location, and are used to check the analyzing laboratory's accuracy. Duplicates should account for 5% of the samples collected quarterly.

4. FIELD DATA

Field data is at least as important as the analytical data received from the outside laboratory. Because field data includes an evaluation of the specific instantaneous conditions at the site, this information cannot be reproduced by a later trip to the site. The field data is also, in many instances, the first indication that there may be a concern with water quality at a given location. Therefore it is critical that any conditions observed are recorded in the field book.

4.1. *Field Notes / Field Log Book*

Field notes will be recorded in a permanently bound, "waterproof" notebook. A dedicated field notebook will be kept for TSPP monitoring. The year and area will be neatly written in permanent ink on the spine and front cover of each book. Xerox copies of all field notes will be maintained in the Newmont South Area Environmental offices and the TSPP Environmental office and will be updated quarterly. This system ensures that the field data will be preserved in the event of fire or other unusual circumstance, as well as provide convenient access to this data by all department staff.

The field book contains compliance data, and therefore can be used in any compliance related proceedings. The sampler should strive to keep these notes suitably neat and well organized. Field notes shall be taken in pen with no erasures. Errors will be crossed out with a single line and corrected. The sampler will initial such corrections at the time they are made.

Field data recorded at each sampling site will include, at a minimum, pH, conductivity, temperature and depth to water. In addition, any other notable conditions will be recorded. In many instances, careful recording of field observations has provided clues to questionable analytical results, thus saving considerable time and money. These observations may include water color, appearance, presence of floating matter or unusual amounts of suspended material, evidence of recent activity in the area or recent access by other persons, wildlife or stock, pumping rates (for well samples), or any conditions that could conceivably impact water quality. Finally, a description of each sampling location will be recorded in the field book during collection of the first sample from that location.

4.2. *Calibration*

All field instruments will be calibrated. The calibration and calibration check shall be documented in the field book. Calibration data will not be used to alter any readings taken during the day. Calibration procedures for typical instruments used in TSPP monitoring is included as Appendix A. Since instruments can change; however, it is important to consult instrument manuals and follow the manufacturer's specifications for calibration.

5. COLLECTION AND PRESERVATION OF SAMPLES

The objective of sampling is to collect a representative sample that insures the analytical results accurately represent the material being sampled. These SOPs ensure that this is achieved. When alternative sampling methods are necessary due to unusual circumstances, the sampler will state plainly the nature of the modification in the field log book.

5.1. *General Guidelines*

Samples will be collected in new sample bottles of material consistent with the parameters to be analyzed. Samples to be analyzed for organics or dissolved oxygen will be collected in amber glass bottles with fluorocarbon resin-lined lids. All other samples may be collected in polyethylene bottles with polyethylene lids. Samples shall be preserved as required by the analysis. Appendix B is a tabulation of required containers (size and material), preservatives and holding times for specific analysis.

DO NOT touch the inside of sample vessel or cap or allow these surfaces to contact any material other than the sample media. Sample containers that are known, or suspected, to be contaminated will be discarded to prevent their use.

Disposable latex surgical gloves will be worn during collection and preservation of samples to minimize potential contamination of the sample, and to protect hands from preservatives and process water.

When filling containers leave a small air space to allow for thermal expansion, unless sampling for organics or dissolved oxygen which require zero head space.

5.2. *Field Log Book*

A detailed record will be made at the time of collection of all pertinent information related to the sample. See Section 4.4 - Field Notes for appropriate information.

5.3. *Sample Identification*

Gummed paper labels or tags will be filled out with waterproof ink at the time the sample is collected. The labels should contain the following information: date and time of sample collection, sample location, sample identification (ID#), name of collector, whether the sample was filtered, and type of preservative used. The labels must be attached to the appropriate sample bottle. In the absence of labels, write the above information directly on the sample bottle with a permanent marker.

Care must be exercised to ensure that the sample ID# is the same as the official designation for each sample location. Failure to use the same ID# as specified in the applicable permit may result in analytical results being questioned.

Duplicate and control samples will be identified with an ID# which will not bias the laboratory by indicating the origin of the sample.

5.4. *Sample Collection*

Decontaminate all non-dedicated sampling equipment and meters, as appropriate, before and after use with deionized water. Triple rinsing is usually sufficient.

To assure an undiluted sample is collected, field cups, filter vessels, or other reusable equipment should be triple rinsed with sample solution if sufficient quantities are available. Otherwise normal decontamination with deionized water is acceptable.

Field readings will be measured from a separate container collected at the same time as the sample, and will not be taken from the actual sample bottle which will be analyzed. If a field sample was taken from a lined facility, it must be returned to a lined facility. Minimum field readings will be pH, conductivity, and temperature.

Sample collection from well, stream, pond, reservoir, & waste rock discussed below.

5.4.1. *Well Sampling*

At the beginning of each sampling event measure depth, to the nearest one-tenth of a foot, to static water level from the top of casing (TOC) with a water level indicator (Solinst or equivalent). The level indicator will be rinsed with deionized water before and after use.

A dry well will be recorded as "Dry at X feet" to assure that the water level indicator did not hang up in the well.

Water standing in a well prior to sampling is not representative of in-situ ground water quality. Therefore, the stagnant water must be removed and replaced by fresh formation water. EPA protocol dictates that one to ten volumes of water standing in the well casing should be removed prior to collection of the sample. However, some wells yield such low volumes of water that this protocol cannot be followed. When sampling a low yield well evacuate the well to dryness once. Within 24 hours of this purge, collect, preserve, and handle the sample(s) according to normal procedures.

When sampling a high yield well, three casing volumes will be evacuated prior to sampling. After measuring depth to water the well volume should be determined according to the procedure in Appendix C to determine purge volume. Measure pH, temperature, and conductivity after each well volume is evacuated (i.e., if the well volume is 5 gallons, take measurements after evacuation of 5, 10, and 15 gallons). Record the volume of water evacuated, the pH, temperature, conductivity, and time that the measurements were made. After three well volumes have been purged check the last two sets of measurements to determine if the field parameters have stabilized. If the field readings have not stabilized purge another well volume and take field measurements. Repeat until stabilized.

To be considered stable, the conductivity values should be within 10% and the pH should be within 0.2 s.u., without rounding (for example, pH values of 7.18 and 7.42 are not within 0.2 s.u., although if these values were rounded to the nearest tenth,

stable conditions would be indicated). If the field values indicate stable conditions, collect, preserve, and handle the samples according to the procedures outlined in this document.

Well collars should be closed and locked when not being sampled.

5.4.2. Pond Sampling

Extra safety precautions should be undertaken when sampling impounded water. A long handled dipper is recommended to obtain the sample. Care should be taken to avoid stirring up any sediments at the sampling site. Note aspects of the sample site in the field notebook.

5.5. Filtering Samples

Per permit specifications, TSPP ground water samples are not filtered.

5.6. Sample Preservation and Storage

Sample preservation is intended to retard breakdown of the constituents within the sample prior to sample analysis. Preservation methods include pH control, chemical control, temperature control, and protection from light. Common sample preservation measures include the following:

Parameter	Minimum Sample Size (ml)	Preservation
Ions, TDS, pH, SC	500	Unpreserved, refrigerate in dark at 4°C
Metals	500	HNO ₃ to pH<2
N, NO ₃ , P, PO ₄ , TOC	500	H ₂ SO ₄ to pH<2

A parameter-specific summary of sample preservation measures is presented in Appendix B. Samples for multiple determinations will need to be split and preserved separately if preservation requirements differ.

Sample preservatives are provided by the lab that supplies the sample containers. Containers should be carefully checked to ensure the preservative is consistent with the parameter being analyzed. The shorter the time that elapses between the collection of a sample and its analysis, the more reliable will be the analytical results

To avoid changes in the concentration or physical state of the constituent to be analyzed, preserve accordingly, and pack samples in ice containers in the field and when shipping. Samples should be stored in a dedicated storage refrigerator and

shipped to the laboratory as soon as possible. As samples are transferred to the storage refrigerator, a double-check that the lids are securely tightened is conducted.

5.7. *Volatile Organic Compounds (VOC)*

When collecting samples for organic analysis: avoid contact with plastics, and keep the sampling area clear of emissions from tailpipes and other fuel-powered motors as the by-products of combustion could contaminate the sample.

Collect a minimum of two vials for each sample. Transfer the samples to 40 ml VOC vials; carefully fill the sample containers until the sample overflows the mouth of the vessel. Preserve the sample with HCL until the pH is below 2 (2 - 3 drops). Replace the cap and septum securely, making sure that the septum is replaced with the Teflon lined surface oriented downward and that no air pockets or bubbles are present in the container. When transferring the sample do so slowly and carefully so as not to agitate the sample excessively as this could result in the loss of volatile analytes.

6. CHAIN OF CUSTODY PROCEDURES

Chain of custody procedures will allow for the tracking of individual samples from the time of collection through laboratory analysis. All records relating to chain of custody documentation are to be made in ink. If errors are made on any of these documents, corrections are to be made by crossing a single line through the mistake and entering the correct information. All corrections are to be initialed and dated by the individual making the error, if possible, or by the investigator. All paperwork completed in the course of collecting and shipping samples must be correct, accurate, and defensible in a court of law.

6.1. *Field Log Book*

The field log book contains the first record in the chain of custody of the sample. It is previously discussed in Section 4.0 (Field Data) of this document.

6.2. *Chain of Custody Record*

A chain of custody record supplied by the analytical laboratory will be completed and must accompany each sample or each cooler of samples (see Appendix D). The record will include the following information: specific area/permit name, sample identification, sample type (well, grab, soil, other), preservative(s) used, whether the sample was filtered, type of analyses required, number of sample containers, signatures of persons involved in the chain of possession and inclusive dates of possession. One copy of the chain of custody is retained by TSPP. The laboratory keeps one copy for its records, and returns a copy to TSPP with the analysis reports.

6.3. *Shipping Papers*

A standard Newmont shipping and receiving form is attached to the top of the cooler or shipping container along with a laboratory's address label. The cooler or shipping container must be secured with shipping fasteners or packing tape to prevent opening during transportation.

6.4. *Delivery to Laboratory*

Samples should be shipped via next day express shipping to the laboratory as soon as possible after the sample is collected. Maximum holding times from the date of sampling should be checked to ensure the samples will arrive at the laboratory with sufficient time for a valid analysis (see Appendix A). Planning is required to ship the samples so the lab personnel are available to receive them, especially if shipping over the weekend. If a rush analysis is requested, notify the laboratory ahead of time. **Note:** For water quality samples there must be enough ice in the cooler to ensure the sample temperature is maintained at 4 degrees Celsius.

Radiological samples (Radium 226, Radium 228) have long holding times and do not require express shipping. These samples may also be shipped without temperature control.

7. WELL SAMPLING EQUIPMENT

At TSPP, all wells are equipped with dedicated Grundfos submersible pumps that are powered by a portable generator. All equipment should be used according to the manufacturers' guidelines and, when appropriate, the oil level should be checked daily.

APPENDIX A
INSTRUMENT CALIBRATION AND USE

BECKMAN PH and TEMPERATURE METER

Operating instructions are on back of meter.

The meter must be calibrated at the beginning of the day before samples are taken, and a calibration check conducted after sampling is completed to be sure the meter has not drifted during the day. Calibration and calibration check must be entered in the Field Log Book.

To Calibrate at beginning of sampling day:

1. Place pH and temperature probes in the 7 pH buffer.*
2. Press "CAL".
3. When the "eye" symbol for Auto stops blinking, record the pH and temperature in the Log Book.
4. Rinse and insert probes in the 10 pH buffer, and press "CAL". When Auto locks in, record in Log Book. Turn meter off.

* Additional calibration pH buffers may be required i.e. pH 2, 4 if sampling event(s) require collection of low pH solutions.

To Use:

1. Do **not** use collected Unpreserved sample for field readings. Rinse probes with deionized water and place pH and temperature probes in the field readings sample. Press ON and pH. When Auto locks in, record readings. Turn meter off.

To check calibration at end of sampling day:

1. Take normal pH reading by placing pH and temperature probes in the 7 pH buffer* and pressing Read. When Auto locks in, record readings in Log Book.
2. Rinse and place in pH 10 buffer, press Read. When Auto locks in, record in log book. Turn meter off.

Storage

The pH probe should be stored with the tip in pH 7 buffer solution and the black protective cap on. Dip the pH probe in the 7 pH buffer solution, do not rinse, and replace protective cap.

Change pH 7 and pH 10 buffer solutions weekly. Buffer solutions may be ordered from the warehouse.

The meter has a battery indicator light if battery is low. The instruction manual contains trouble shooting tips.

BECKMAN CONDUCTIVITY METER

Calibration and operating instructions are on the back of meter. The meter should be sent to manufacturer annually for maintenance.

Calibration:

To calibrate the meter

1. First calibration point, hold sensor in ambient air.
2. Press cal – cal 1 is displayed. After end pointing, the display automatically updates to the calibrated value shown, or the temperature compensated value. If read is pressed after Cal 1 update, the meter assumes one point calibration only is required.
3. Second calibration point – place sensor in the second calibration medium (Standard Solution, 1413 uS or 12.88 mS). Press cal – cal 2 is displayed. After end pointing, the display automatically updates to the calibrated value shown, or the temperature compensated value
4. Samples may now be measured.

To Use:

1. Immerse probe to halfway point in solution.
2. Press read to turn meter on and start measurement. Automatic endpoint detection freezes the display when plateau is reached.

APPENDIX B

SAMPLE CONTAINERS, PRESERVATION and HOLDING TIMES

RECOMMENDATIONS FOR SAMPLING AND PRESERVATION OF WATERS

MEASUREMENT	Volume Required (mL)	Container P=Plastic G=Glass	PRESERVATIVE	HOLDING TIME
Preservative ampules: HNO ₃ – nitric acid (red cap), H ₂ SO ₄ - sulfuric acid (yellow cap), HCl - hydrochloric acid (blue cap), H ₃ PO ₄ - phosphoric acid (white cap), NaOH - sodium hydroxide (green cap), or zinc acetate (purple cap).				
Major minerals, including the following: Potassium, Sodium, Calcium, Magnesium, Sulfate, Chloride, Bicarbonate, Carbonate, pH, Specific Conductance, Total Dissolved Solids	500	P or G	Cool, ≤ 6°C	see holding times for each individual parameter, below
METALS				
Dissolved Metals	250	P or G	Filter (0.45 micron), then add HNO ₃ to pH <2	6 months
Total Metals	250	P or G	HNO ₃ to pH <2	6 months
Chromium ⁺⁶	200	P or G	Cool, ≤ 6°C	24 hours
Ferrous Iron (Fe II - requires field filtering)	100	P or G	Filter (0.45 micron), then add HNO ₃ to pH <2	6 months
Mercury	100	P or G	same as tot. or diss. Metals	28 days
NON-METALLICS				
Acidity	100	P or G	Cool, ≤ 6°C	14 days
Alkalinity	100	P or G	Cool, ≤ 6°C	14 days
Biochemical Oxygen Demand (BOD)	1000	P or G	Cool, ≤ 6°C	48 hours
Bromide	100	P or G	None Required	28 days
Carbonaceous BOD	1000	P or G	Cool, ≤ 6°C	48 hours
Chemical Oxygen Demand (COD)	50	P or G	H ₂ SO ₄ to pH <2, Cool, ≤ 6°C	28 days
Chloride	50	P or G	None Required	28 days
Chlorine	50	P or G	None Required	15 minutes
Chlorophyll a	1000	P or G	Cool, ≤ 6°C, keep in the dark	NA
Color	50	P or G	Cool, ≤ 6°C	48 hours
Conductance	100	P or G	Cool, ≤ 6°C	28 days
Cyanates	250	P	NaOH to pH >12, Cool, ≤ 6°C	14 days
Cyanides	500	P or G	NaOH to pH >12, Cool, ≤ 6°C	14 days
Ethylene Glycol	500	P or G	Cool, ≤ 6°C	NA
Formaldehyde	100	P or G	Cool, ≤ 6°C	NA

RECOMMENDATIONS FOR SAMPLING AND PRESERVATION OF WATERS, continued

MEASUREMENT	Volume Required (mL)	Container P=Plastic G=Glass	PRESERVATIVE	HOLDING TIME
NON-METALLICS continued				
Fluoride	50	P or G	None Required	28 days
Iodide	100	P or G	None Required	28 days
Hardness	100	P or G	Cool, $\leq 6^{\circ}\text{C}$	6 months
Methane	40 mL VOA vial-no headspace-4 drops H_2SO_4			NA
Nitrogen, Ammonia	50	P or G	H_2SO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Nitrogen, Total Kjeldahl	500	P or G	H_2SO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Nitrogen, Nitrate plus Nitrite	50	P or G	H_2SO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Nitrogen, Nitrate	50	P or G	Cool, $\leq 6^{\circ}\text{C}$	48 hours
Nitrogen, Nitrite	50	P or G	Cool, $\leq 6^{\circ}\text{C}$	48 hours
Nitrogen, Total (Persulfate Method)	50	P or G	Cool, $\leq 6^{\circ}\text{C}$	NA
Oil and Grease	2 - 1000	G	H_2SO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Organic Carbon	125	G	H_3PO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Organic Carbon, Public Water Supply	500	G	H_3PO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
pH	25	P or G	None Required	15 minutes
Phenolics by E420.4	250	G	H_2SO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Phenols by E420.1 distillation	2 - 1000	G	H_2SO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Phosphorus, Hydrolyzable	250	P or G	H_2SO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Phosphorus, Ortho	250	P or G	Filter within 15 minutes, Cool, $\leq 6^{\circ}\text{C}$	48 hours
Phosphorus, Total	250	P or G	H_2SO_4 to pH <2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Residue, Filterable Total Dissolved Solids (TDS)	500	P or G	Cool, $\leq 6^{\circ}\text{C}$	7 days
Residue, Non-filterable Total Suspended Solids (TSS)	1000	P or G	Cool, $\leq 6^{\circ}\text{C}$	7 days
Residue, Total	100	P or G	Cool, $\leq 6^{\circ}\text{C}$	7 days
Residue, Volatile Volatile Suspended Solids (VSS)	100	P or G	Cool, $\leq 6^{\circ}\text{C}$	7 days
Settleable Matter	1000	P or G	Cool, $\leq 6^{\circ}\text{C}$	48 hours

RECOMMENDATIONS FOR SAMPLING AND PRESERVATION OF WATERS, continued

MEASUREMENT	Volume Required (mL)	Container P=Plastic G=Glass	PRESERVATIVE	HOLDING TIME
NON-METALLICS continued				
Sulfate	100	P or G	Cool, $\leq 6^{\circ}\text{C}$	28 days
Sulfide	250	P or G	Add 2 mL zinc acetate, zero headspace, NaOH to pH > 9, Cool, $\leq 6^{\circ}\text{C}$	7 days
Sulfite	100	P or G	1 mL of EDTA	15 minutes
Surfactants (Foaming Agents)	500	P or G	Cool, $\leq 6^{\circ}\text{C}$	48 hours
Tannins & Lignins	25	P or G	Cool, $\leq 6^{\circ}\text{C}$	14 days
Thiocyanates	100	P or G	HNO_3 to pH < 2	NA
Total Petroleum Hydrocarbons (TPH)	2 - 1000	G	H_2SO_4 to pH < 2, Cool, $\leq 6^{\circ}\text{C}$	28 days
Total Petroleum Hydrocarbons (TPH) by TCEQ 1005	3-VOA vials with zero headspace	G	HCl to pH < 2, Cool, $\leq 6^{\circ}\text{C}$	14 days
Turbidity	100	P or G	Cool, $\leq 6^{\circ}\text{C}$	48 hours
BACTERIA				
Total Coliform Bacteria	120	Sterile	Cool, $\leq 6^{\circ}\text{C}$	30 hours
Fecal Coliform Bacteria	120	Sterile	Cool, $\leq 6^{\circ}\text{C}$	8 hours
Heterotrophic Plate Count	120	Sterile	Cool, $\leq 6^{\circ}\text{C}$	24 hours
Sulfate Reducing Bacteria	120	Sterile	Cool, $\leq 6^{\circ}\text{C}$	48 hours
Iron Bacteria	100	Sterile	Cool, $\leq 6^{\circ}\text{C}$	NA
RADIOCHEMISTRY				
Gross Alpha	2 - 1000	P or G	HNO_3 to pH < 2	6 months
Gross Beta	2 - 1000	P or G	HNO_3 to pH < 2	6 months
²¹⁰ Pb	2 - 1000	P or G	HNO_3 to pH < 2	6 months
²¹⁰ Po	2 - 1000	P or G	HNO_3 to pH < 2	6 months
²²² Rn	3-VOA vials with zero headspace	G	Cool, $\leq 6^{\circ}\text{C}$	8 days
²²⁶ Ra	2 - 1000	P or G	HNO_3 to pH < 2	6 months
²²⁸ Ra	2 - 1000	P or G	HNO_3 to pH < 2	6 months
²³⁰ Th	2 - 1000	P or G	HNO_3 to pH < 2	6 months
Uranium	2 - 1000	P or G	HNO_3 to pH < 2	6 months

APPENDIX C
WELL PURGING CALCULATION

WELL EVACUATION CALCULATION - EXAMPLE

1. Measure depth to water from top of casing (TOC) prior to purging.
2. Begin purging well.
3. Determine well casing volume.

Total depth of well (TD) - depth to water (DTW) = total height of water in casing (H).

Example: TD = 66.60'

DTW = 46.15'

H = 20.45'

Volume in cubic feet (Vc) = 3.14 x (radius of well)² x H

Example: with a 4" casing, radius = 2" = 0.167'

$$Vc = 3.14 \times (0.167')^2 \times 20.45'$$

$$Vc = 0.09 \text{ square feet} \times 20.45 \text{ feet}$$

$$Vc = 1.8 \text{ cubic feet}$$

4. Convert cubic feet to gallons.

Cubic feet x 7.48 = gallons

Example: Vg = 1.8 cubic feet x 7.48 = 13.5 gallons

5. Three well volumes must be evacuated:

Example: $V_{w3} = 3 \times 13.5 \text{ gallons} = 40.4 \text{ gallons}$

6. Hence, to evacuate three well volumes in the above example, 40.4 gallons need to be purged before sampling.

Since all values in the above calculations are constant except for the height of water in casing (H), the constant values may be pre-calculated to simplify well volume determinations. Thus:

For a 2" well, three well volumes (V_{w3}) = H x 0.5

For a 4" well, three well volumes (V_{w3}) = H x 2

APPENDIX D
CHAIN OF CUSTODY RECORD



CHAIN OF CUSTODY RECORD

Page ____ of ____

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FOR SVL USE ONLY SVL JOB #
TEMP on Receipt

Table 1. -- Matrix Type 1 = Surface Water, 2 = Ground Water 3 = Soil/Sediment, 4 = Rinsate, 5 = Oil 6 = Waste, 7 = Other

Report to Company: _____ Contact: _____ Address: _____ _____ Phone Number: _____ FAX Number: _____ E-mail: _____	Invoice Sent To: _____ Contact: _____ Address: _____ _____ Phone Number: _____ FAX Number: _____ PO#: _____
-------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------

Project Name: _____
 Sampler's Signature: _____

Indicate State of sample origination: _____ USACE? Yes No

Sample ID	Collection		Misc. Collected by: (Init.)	Preservative(s)							Analyses Required	Rush Instructions (Days)	Comments	
	Date	Time		Matrix Type (From Table 1)	No. of Containers	Unpreserved	HNO ₃ Filtered	HNO ₃ Unfiltered	HCl	H ₂ SO ₄				NaOH
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

* Sample Reject: Return Dispose Store (30 Days)

White: LAB COPY Yellow: CUSTOMER COPY

ATTACHMENT B
Technical Memorandum
Background Analysis (NewFields, 2016)

TECHNICAL MEMORANDUM

To: Mr. Dennis Laybourn
Senior Environmental Manager

From: Brian Wellington, Paul Kaplan

Project: CCR Landfill, TS Power Plant Project

Project No: 475.0221

Subject: Background Analysis – Revision 0

Date: July 8, 2016

1. INTRODUCTION

Newmont Nevada Energy Investment has conducted field investigations to characterize background conditions of ground water at the TS Power Plant Ash Landfill. This characterization involved the collection of groundwater data during the period November 2005 to February 2016. The available data provides a comprehensive dataset upon which background concentration limits of various chemical constituents in groundwater can be determined. These limits will be used for future compliance monitoring under the Coal Combustion Residue Rules (CCR). The determination of background upper limits of chemical constituents in groundwater was conducted through a series of statistical evaluations.

2. METHODOLOGY

2.1. Assessment of Groundwater Data

Prior to determination of background concentration limits for groundwater constituents, the consistency of existing groundwater data relative to the underlying statistical assumptions is examined. Specifically, a background dataset must often meet the following criteria:

1. Data independence: Each measured concentration is independent of other measurements in the same dataset.
2. Temporal Stationarity: The statistical properties of the background dataset, including its mean and standard deviation, should not exhibit secular (increasing or decreasing) temporal trends.
3. Typically, background datasets are generated by repeated sampling of multiple wells within a given water bearing unit/aquifer. Pooling of datasets is commonly performed, because larger datasets are expected to yield more reliable results. However, such combinations are acceptable, if the constituent subsets display similar statistical properties, which can be tested through appropriate statistical tests.



The statistical procedures used to assess the suitability of the groundwater data set for background analysis are described below. All computations are performed using the IBM SPSS version 19.0 (SPSS, 2010) software.

2.1.1. Data Independence

Data independence was assessed by use of time series analysis to determine the temporal independence of groundwater data. In this work, the autocorrelation analysis is employed to assess data independence. For this purpose, the correlation between any measurement of a given variable and its subsequent measurement in the time series is computed. The computed value is sometimes referred to as “the first lag correlation.” The data independence is confirmed if the computed first lag correlation is not significant at 5% level. For a detailed explanation of autocorrelation analysis, readers are referred to Salas (1993).

2.1.2. Temporal Stationarity

Secular trends were assessed using the Mann-Kendall test, a non-parametric procedure that determines the absence or presence of trends/correlations in an ordered paired data set. The test makes no assumption as to the underlying distribution of the dataset. The non-parametric measure of correlation is referred to as Kendall’s τ , whose calculated value can vary from -1 to +1 with -1 representing a perfectly decreasing trend and +1 representing a perfectly increasing trend. In this investigation, trends with Kendall’s τ coefficients that represent a strong negative or positive correlation, i.e. with absolute values exceeding 0.5, and meeting the 5% significance criterion, are considered as statistically significant secular trends. For a detailed explanation of Mann-Kendall test, readers are referred to Helsel and Hirsch (1995) and Gilbert (1987).

2.1.3. Data Pooling

Data from different wells in the same water bearing unit are pooled, if they exhibit similar statistical properties, i.e. if their mean and variance are similar. In order to assess the appropriateness of pooling, the data are analyzed using a One Way ANOVA analysis combined with a suitable Post Hoc Multiple Comparison analysis in a three step process.

Step 1: Measurements of constituents from wells within a given water bearing unit are subjected to Levene test (Helsel and Hirsch (1995) and Gilbert (1987)) to determine whether the sample variances of the constituents among the targeted wells are similar. The results of the Levene test dictates the appropriate Post Hoc Multiple Comparison method.

Step 2: The One way ANOVA test is applied to measurements from the target wells to determine whether their means are similar.



Step 3: If the Levene test confirms statistical similarity of variances of two or more wells in Step 2, then Post Hoc comparisons are performed with the Tukey method. However, if equal variances cannot be assumed then the Games-Howell Post Hoc Method is utilized

The data from the targeted wells are pooled, if their variance and median are proved to be statistically similar. In all the above tests, 5% significance criterion is used.

For a detailed explanation of the One-Way ANOVA analysis, readers are referred to Helsel and Hirsch (1995) and Gilbert (1987).

2.1.4. Determination of Upper Background Limit for Groundwater

The upper background limit (UBL) of all data are calculated as the 95% upper tolerance limit with 95% coverage. The UBL are based on the underlying population of the data. Where the underlying population cannot be identified, a non-parametric method was used for analysis. The UBL analysis was performed using ProUCL (USEPA, 2010).

Non-detect values in the data set were handled in one of two ways depending on the percentage of non-detects within the dataset and whether the underlying distribution of the data could be identified. For dataset with a small percentage of non-detects (less than or equal to 20%) and whose distribution was identified as normal the maximum likelihood estimation (MLE) method was used. In cases where this criteria was not met a suitable robust statistical method was used for handling non-detects. If the underlying distribution of the data was identified as a gamma distribution, the Regression on Ordered Statistics (ROS) method was used. The Kaplan-Meier method was employed for all other cases. The procedures outlined above were used in all UBL calculations in which the non-detect values consisted of a single reported detection limit (RDL). If the dataset included multiple RDLs for the constituent then the Kaplan-Meier method was used irrespective of the underlying distribution of the data. Refer to the ProUCL technical guidance document (USEPA, 2010) for a more detailed description of these methods.

2.2. Results

2.2.1. Groundwater

2.2.1.1. Data Description

The investigated background dataset consists of groundwater data from 4 wells TSMW-1, TSMW-3, TSMW-4, and TSMW-8. In each of these wells background values for the following analytes, were determined: Arsenic, Barium, Selenium, Chloride, Total Dissolved Solids (TDS) and Total Organic Carbon (TOC). The investigated wells and analytes were selected based on the sampling locations and compliance monitoring requirements detailed in the Groundwater



Monitoring Plan (April 2016) for the TS Power Plant Ash Landfill. A summary of the data is provided in Appendix A-1.

2.2.1.2. Data Independence

A summary of the first lag correlation results for each analyte using all existing data at each well is shown in Table 1 and data with significant correlations are highlighted.

Table 1: Calculated first lag correlation coefficient significance levels for constituents. Highlighted values are significant at 5% level

Well ID	TDS	Arsenic	Barium	Selenium	TOC	Chloride
TSMW-1	0.978	0.172	0.000	0.001	0.098	0.001
TSMW-3	0.000	0.934	0.100	0.241	0.040	
TSMW-4	0.001	0.815	0.008	0.000	0.684	
TSMW-8						

As indicated in Table 1 some analytes within some wells have significant first lag correlations. However, on further investigation of these time series, it was determined these autocorrelations are mainly caused by older data or as in the case of TOC in TSMW-4 by a continuous series of non-detect values. The more recent data of these analytes in the above wells, collected within last 3 years (2013 to 2016), show no significant first lag correlation (Table 2) with the exception of TDS in TSMW-4. It can therefore be concluded that in general the groundwater data are independent and suitable for background analysis.

Table 2: Calculated first lag correlation coefficient significance levels for constituent (post 2012 data). Highlighted values are significant at 5% level.

Well ID	TDS	Arsenic	Barium	Selenium	TOC	Chloride
TSMW-1	0.127	0.444	0.257	0.441	0.181	0.993
TSMW-3	0.237	0.646	0.564	0.996	0.979	
TSMW-4	0.019	0.943	0.112	0.368		
TSMW-8						

2.2.2. Temporal Stationarity

The secular trends results based on all existing data and calculated using the Mann-Kendall test are provided in Table 3.



Table 3: Mann-Kendall secular trend results for analyte concentrations within wells showing a statistically significant trend. Highlighted values are significant at 5% level.

Well ID	TDS		Arsenic		Barium		Selenium		TOC		Chloride	
	kendall_tau	sig	kendall_tau	sig	kendall_tau	sig	kendall_tau	sig	kendall_tau	sig	kendall_tau	sig
TSMW-1	-0.357	0.000	-0.041	0.355	0.214	0.034	-0.699	0.000	-0.060	0.330	-0.450	0.000
TSMW-3	0.217	0.039	-0.151	0.113	-0.176	0.079	-0.277	0.012	-0.304	0.016		
TSMW-4	-0.403	0.001	0.334	0.003	-0.411	0.001	-0.507	0.000	0.225	0.052		
TSMW-8												

In general, where constituents in wells exhibit a trend they are removed from analysis. In this analysis only selenium in TSMW-1 exhibits a significant trend.

2.2.2.1. Data Pooling

The One Way ANOVA analysis indicated that while some analytes in some wells exhibited similar statistical properties overall the results were inconsistent and thus a discussion was made not to pool data together for further analysis. However, it was observed the measured concentrations of Arsenic, Barium, Selenium, and TOC in TSMW-8 appear to be statistically similar to those measured in TSMW-4. Thus, it is recommended that future measurements of these constituents in TSMW-8 be compared to their established background values in TSMW-4.

2.2.3. Upper Background Limit

The UBL results and the method of analysis as recommended by ProUCL is presented in Table 4. A Plot of the existing data and UBL are shown in Appendix A2.

Table 4: Upper Background Limit of Constituents Measured in Wells

Well ID	TDS		Arsenic		Barium		Selenium		TOC		Chloride	
	95UTL	Method	95UTL	Method	95UTL	Method	95UTL	Method	95UTL	Method	95UTL	Method
TSMW-1	894	Normal	0.01310	Non Parametric 955 UTL	0.038	Normal	0.0077	Normal	29.64	Normal	135.30	
TSMW-3	865	Non Parametric 955 UTL	0.01360	Normal	0.107	Normal	0.0083	Normal	23.39	Normal		
TSMW-4	859	Normal	0.01500	Normal	0.050	Normal	0.0086	Normal	21.36	Normal		
TSMW-8 ¹			0.01500		0.050		0.0086		21.36			

1 – Based on Data from TSMW-4



3. CONCLUSIONS

The existing groundwater are suitable for determining background concentration limits for analytes to be monitored under the Coal Combustion Residue Rules (CCR). The upper background limits for groundwater concentrations at compliance monitoring location have been calculated and provided in the report.

4. REFERENCES

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- Salas, J.D., 1993, Analysis and modeling of hydrologic time series; in Maidment, D.R., ed., Handbook of Hydrology, McGraw-Hill, New York.
- USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance, EPA 530/R-09-007. Office of Resource Conservation and Recovery Program Implementation Division.
- USEPA, 2010. ProUCL Version 4.1 User Guide (Draft) Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations, EPA/600/R-07/041. Office of Research and Development Washington, Washington, D.C.

APPENDIX A-1
Data Table



Well_ID	TDS					Arsenic					Barium					Selenium					TOC					Chloride				
	Min	Max	Average	Count	% Non Detect	Min	Max	Average	Count	% Non Detect	Min	Max	Average	Count	% Non Detect	Min	Max	Average	Count	% Non Detect	Min	Max	Average	Count	% Non Detect	Min	Max	Average	Count	% Non Detect
TSMW-1	706	876	763	42	0%	0.00800	0.01310	0.01149	41	0%	0.0000	0.0378	0.0261	37	21%	0.0000	0.0080	0.0046	41	5%	0	39.10	3.59	34	60%	100.0	135.0	116.3	33	0%
TSMW-3	716	865	816	33	0%	0.00975	0.01400	0.01144	33	0%	0.0000	0.2000	0.0413	32	6%	0.0046	0.0082	0.0065	33	0%	0	39.10	2.99	33	82%	115.0	135.0	125.0	2	0%
TSMW-4	714	832	786	33	0%	0.01200	0.01530	0.01321	33	0%	0.0322	0.0540	0.0380	32	0%	0.0047	0.0080	0.0066	33	0%	0	45.50	2.39	33	73%	93.8	107.0	100.4	2	0%
TSMW-8	620	645	633	2	0%	0.01350	0.01450	0.01400	2	0%	0.0442	0.0656	0.0549	2	0%	0.0065	0.0070	0.0068	2	0%	0	0.00	0.00	2	100%	104.0	118.0	111.0	2	0%

APPENDIX A-2
Data Charts

