Table 10: Water Quality

Location	Water Type	No. of Samples	"No Flow" (%)	Electrical Conductivity (µS/cm)			pH (dimensionless)			TSS (mg/l)		
				Average	5th %ile	95th %ile	Average	5th %ile	95th %ile	Average	5th %ile	95th %ile
Dirty Water Dam 1	Saline Water (Containment Dams)	168		5344	3467	8377	8.6	8.1	9.1	16	1	58
Dirty Water Dam 2		168		5940	3893	9021	8.6	8.1	9.2	16	1	52
Dirty Water Dam 4		168		4702	847	9506	8.7	7.5	9.6	25	1	89
Railway Underpass	Rixs Creek (Fresh)	154	76	768	110	5063	7.0	6.0	8.1	164	6	532
New England Highway		159	70	1793	379	4892	7.4	6.7	8.4	63	2	263
Below Operation[5]		93	55[6]	1299	277	4706	7.7	7.0	8.4	59	3	190
Maison Dieu Bridge		155	64	1183	259	3675	7.2	6.5	7.9	137	4	437
Clean Water Dam 1	Clean Runoff (Diversion Dams)	168		222	121	347	7.5	6.4	8.9	26	2	80
Clean Water Dam 2		168		205	130	335	7.3	6.4	8.5	17	1	58
Clean Water Dam 6[7]		168		209	120	340	7.8	7.0	8.9	48	5	154
Pit 3 - East	Sediment Dams	5		338	190	469	7.7	6.8	8.2	161	5	619
Pit 3 - West		5		269	118	400	7.6	6.7	8.1	96	9	226
Misc. Sediment Dams		5		200	160	314	6.5	5.8	7.2	394	156	762
Maison Dieu	Hunter River Upstream	2495	0	672	404	945						
Long Point	Hunter River Downstream	6953	0	627	372	936						

[5] Near Chainage 7250 metres on Rixs Creek, measured upstream from the confluence with the Hunter River
[6] The shorter record misses several years of drought prior to 2005. This value of "No Flow" is likely to trend closer to 65-70% over an equivalent time period to the other monitoring stations.
[7] Near Ch. 11730 in Stonequarry Gully which is 195m downstream of the proposed discharge point.

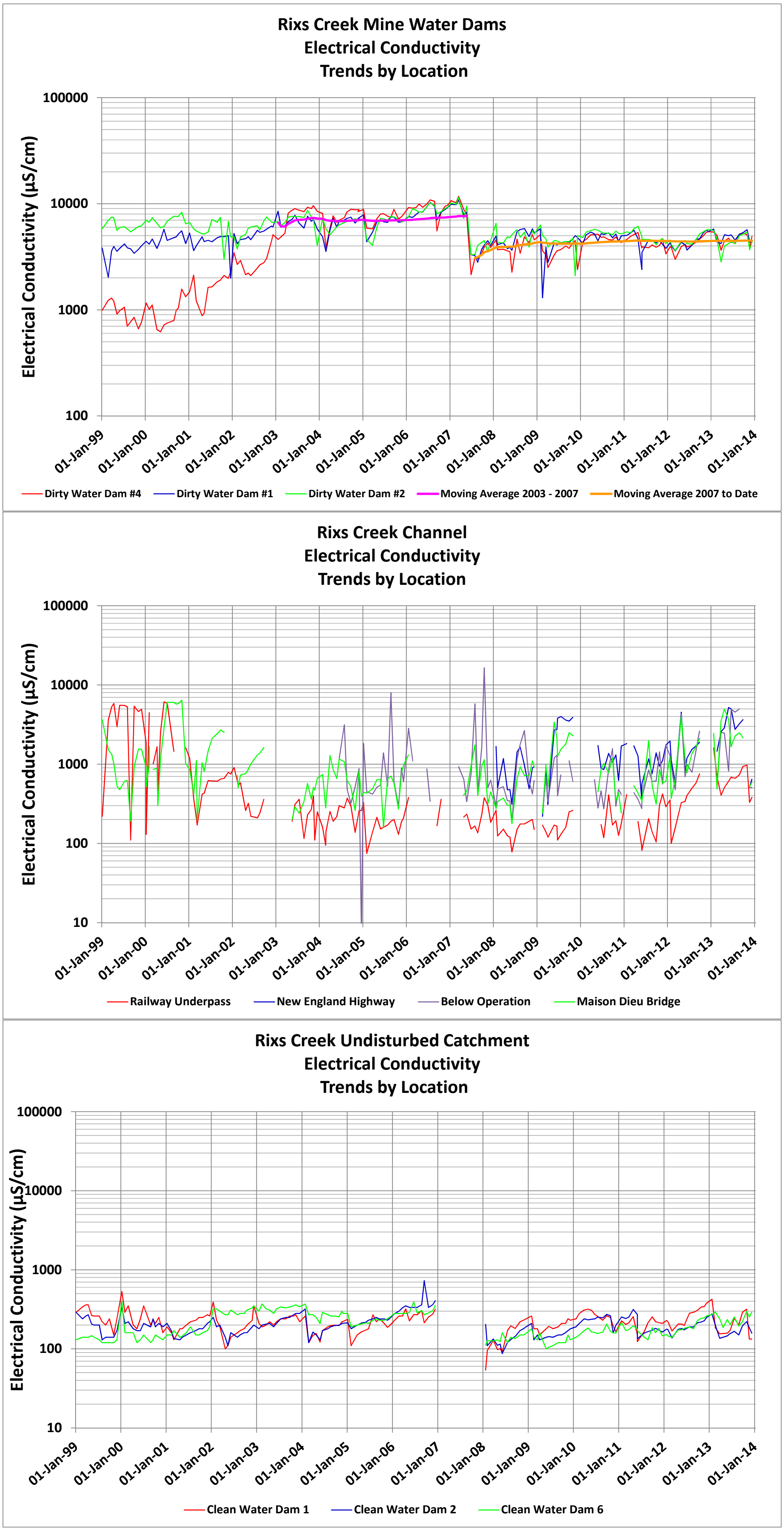
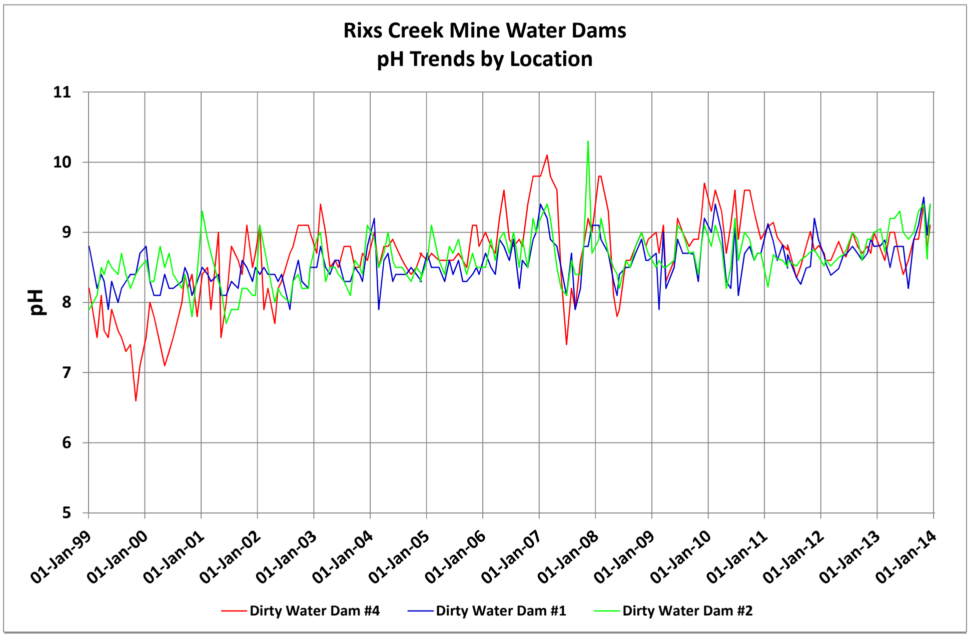
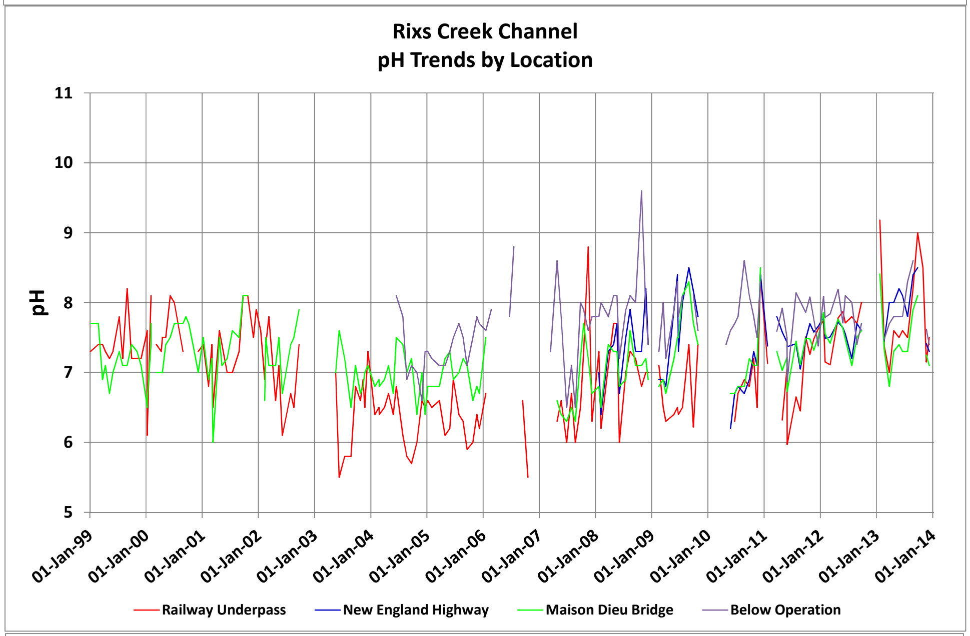


Figure 15: Graphs of Electrical Conductivity Data





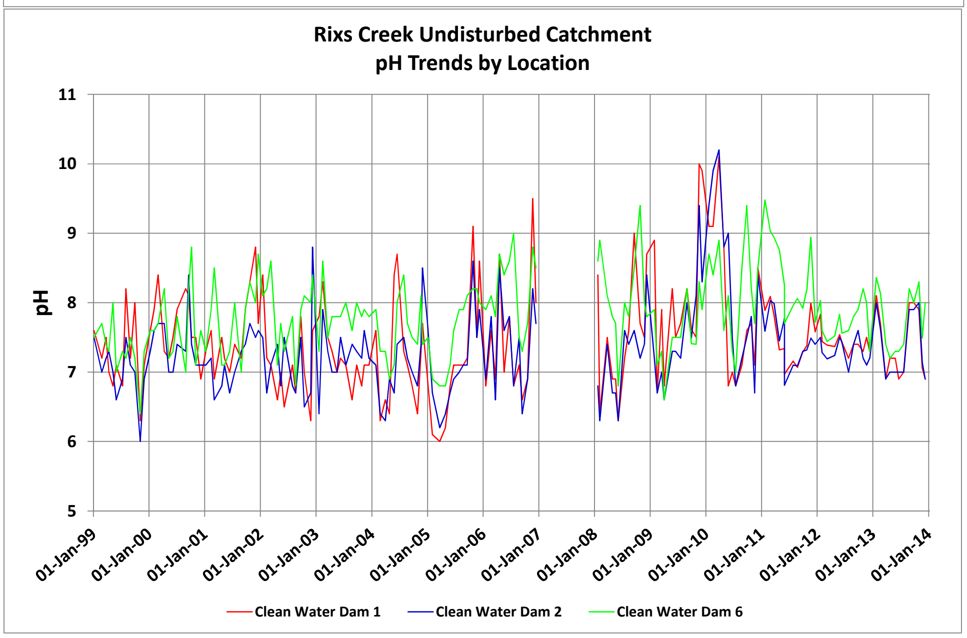


Figure 16: Graphs of pH Data

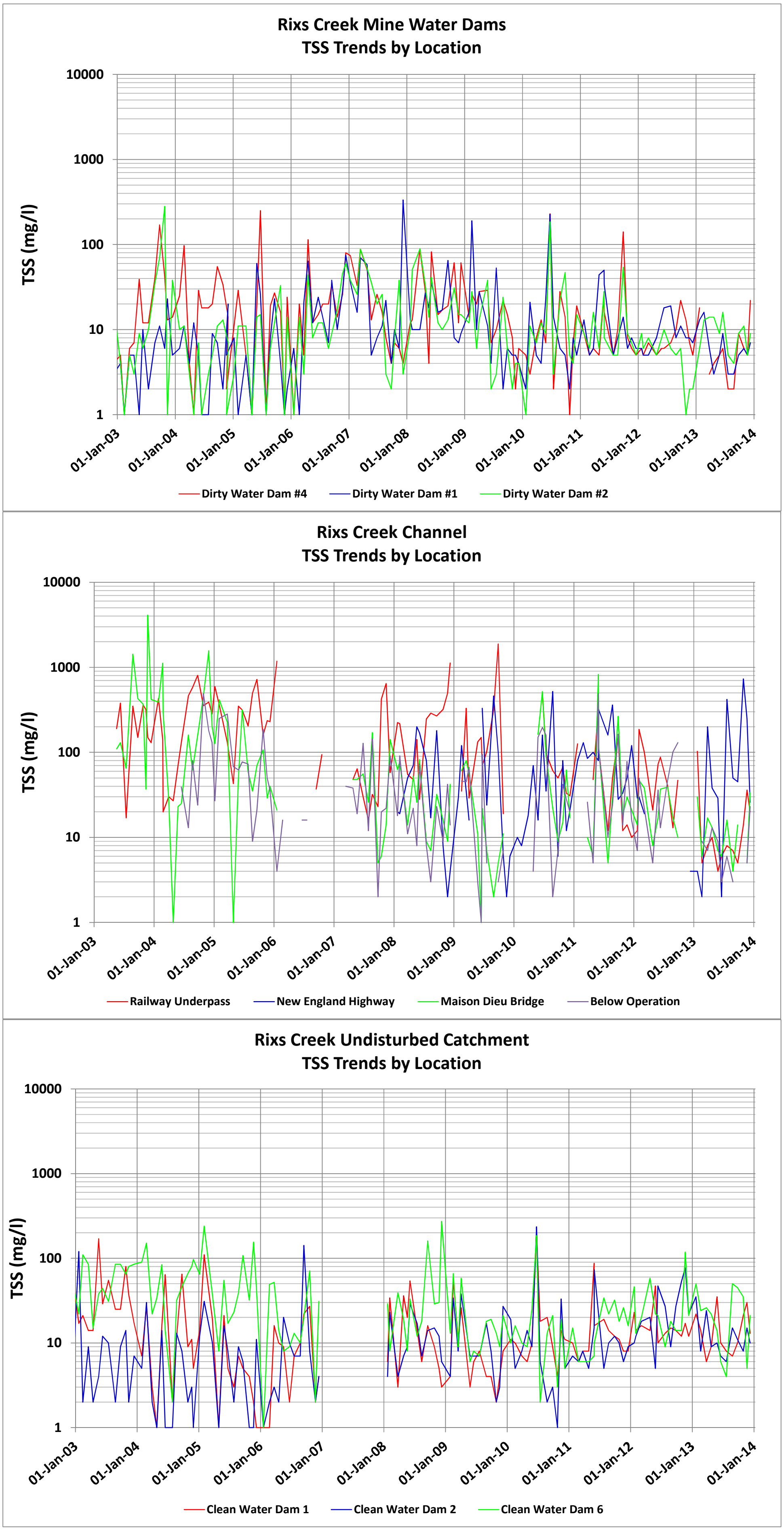


Figure 17: Graphs of Total Suspended Solids Data

3.8.2 Surface Water Management Methodology

Land disturbance associated with mining may adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. Runoff from active mining areas (including roads, coal stockpiles, etc.) may have increased concentrations of salts and other pollutants compared to natural runoff. The surface water generated within the study area is categorised into six types, based on water quality:

- Mine Water: Surface water that has generally come in contact with coal such as in the open cut mining area or from the ROM coal stockpile. This water may contain high TDS, above values that represent fresh water as defined by ANZECC & ARMCANZ (2000).
- Sediment Affected Water: This water is often called dirty water at other mining operations in the Hunter Valley, however Rixs Creek has traditionally reserved this term for mine affected saline water, hence mine water dams are referred to as Dirty Water Dams and numbered DWD 1, DWD 2 etc. and Sediment Dams are numbered SD 1, SD 2 etc. Sediment affected water is surface runoff water from areas that are disturbed by mining activity (including out-of-pit overburden and haul roads). This runoff does not come into contact with coal or other carbonaceous material but may contain high sediment loads. It does not contain contaminated material or elevated salt concentrations. This runoff must be managed to ensure that downstream water quality is within the adopted water quality compliance criteria.
- Clean water: Surface runoff from areas where water quality is unaffected by mining operations. Normally this water is of low salinity, less than 400 μs/cm, the case at Rixs Creek, but at some mines in the Hunter Valley, this runoff can record EC values of 1,000 μs/cm or higher. Clean water includes runoff from undisturbed areas and mature, fully rehabilitated areas.
- Tailings Water: Water that has been used to process coal in the CHPP and transport fine washery reject to tailings dams. Tailings water potentially has a higher concentration of contaminants than Mine affected water and therefore requires a higher level of protection to prevent discharge into the natural watercourses; and
- Contaminated Water: Surface water from areas potentially containing chemicals of various types used in the mining operations. There are restrictions on the use and release of this water. Contaminated water areas include sumps, service bays and fuel storage areas. Rainfall and resulting runoff from these areas is also potentially contaminated and therefore must be managed to avoid discharge of potentially contaminated water into the natural watercourses. This type of surface water runoff is typically treated prior to being reused in the water management system or pumped out by licensed contractors.

- Sewage: This is water collected from the bath house, toilets kitchens etc. There are restrictions on the use and release of this water. Sewage must be managed to minimise human health risk and avoid discharge of potentially contaminated water into the natural watercourses. Sewage is normally treated in site in a package treatment plants, polished and disposed of on-site by irrigation.

3.8.3 System Description

As noted above, the water management system has operated with a surplus in supply under most prevailing climatic conditions. This traditional water surplus is expected to decrease under the new mining configuration due to the contraction of mining areas and disturbed areas. As currently inactive mine voids are progressively filled and rehabilitated and this catchment runoff will be directed back to the external catchments rather than into mine water storages.

Surplus rainfall runoff from mining and coal handling areas is contained on site and directed to the CHPP and dust suppression for re-use during dry periods. The CHPP and dust suppression are the two main consumers of water on the site.

The CHPP has historically pumped fine tailings to dams for disposal and recovered the decanted water off the dams for re-use in the plant. During 2014 the CHPP has been changing over to a tailings decanter centrifuge system which dewaters the tailings at the CHPP. The dewatered tailings cake can be disposed separately or mixed with coarse reject and disposed of in overburden emplacements using trucks.

The opposing effects of reduced catchment runoff and increased tailings recovery have been determined using a site water balance model. The model construction, operation and results are described in **Section 5.0 Water Balance Model**

The Mine does not maintain licensed discharge points to release excess mine water via the Hunter River Salinity Trading Scheme (HRSTS), although this requirement may change as the mining plan is implemented. The Mine holds salt credits that would facilitate release of water under the conditions of the HRSTS if a discharge point is found to be necessary in the future.

Figure 18 shows the site layout in 2014 with the various pits, natural catchments and water storage dams identified. **Figure 19** provides a schematic of the Mine ‘dirty’ water system in 2014. Operation of the system provides for the following:

- Runoff from undisturbed land in the upper north east part of Rixs Creek catchment is diverted around the CHPP and the eastern side of North Pit via a surface drain to Clean Water Dam 6

(CWD 6). CWD 6 spills to Stonequarry Gully which joins the remaining channel of Rixs Creek just north of the New England Highway.

- Runoff from undisturbed land in advance of West Pit is channelised just south of the New England Highway and then conveyed beneath the Highway and the Haul Road Underpass via a series of culverts and channels into Sediment Dam 5 (SD5). SD 5 overflows into Rixs Creek just north of the New England Highway.
- The most recently mined area of North Pit on the boundary with Integra Coal collects mine water runoff and groundwater seepage in the North Pit Sump (Dirty Water Dam 8, or DWD 8). The water is pumped south along the upper benches into a 315mm pipeline to convey water to the CHPP (DWD 4). A component of the inventory of DWD 8 consists of spoil storage with an assumed 20% void space.
- Mine water runoff collects in the North Pit Void (DWD 9) which is located some 1.5 km south of the North Pit sump. The water is pumped south along the upper benches into a 315mm pipeline to convey water to the CHPP. A component of the inventory of this reservoir consists of spoil storage (20% void space).
- Mine water runoff collects in sumps in West Pit and is pumped east along ramps and then north into a 315mm pipeline to convey water to the CHPP. Water is also pumped to DWD 3 to supply a water tanker fill station or conveyed to the CHPP.
- Mine water runoff collects in the decommissioned South Pit (DWD 10). Water is pumped to DWD 3 to supply a water tanker fill station or conveyed to the CHPP.
- The CHPP draws water from DWD 1 and DWD 4 for coal beneficiation, wash down and dust suppression. Thickened fine tailings are pumped to DWD 9, and dewatered tailings cake is trucked to overburden emplacements for disposal. Coarse reject material is trucked to overburden emplacements for disposal.
- A water tanker fill station on DWD 2 is supplied from the CHPP dams DWD 1 and DWD 4.
- DWD 4 has a relatively large catchment consisting of undisturbed and rehabilitated land. Consequently, excess water inventory is pumped from DWD 1 and DWD4 to the Old North Pit (DWD 5) for offline storage and recovery. The CHPP spillways are directed to DWD 5, which is a large in-pit mine water storage.
- The old underground workings are used as offline mine water storage. Water is recovered from the workings under a NSW Office of Water (NOW) bore licence.
- Runoff from rehabilitated areas of North Pit is directed to SD 1, SD 5, SD 6 and SD 7 for settling. The dams and drainage on the rehabilitated surface that direct water to the sediment dams are designed to minimise erosion and deposition whilst flowing. The dams are passive management systems, overflowing when runoff volumes exceed the available storage. Some rehabilitated runoff collects in DWD 5 where it mixes with saline water and is subsequently reused in the Mine.

- Runoff from rehabilitated areas of West North Pit is directed to SD 2 and SD 3 for settling. The dams and drainage on the rehabilitated surface that direct water to the sediment dams are designed to minimise erosion and deposition whilst flowing. The dams are passive management systems, overflowing when runoff volumes exceed the available storage. Intermittent monitoring since 2011 indicates EC is less than 320 µS/cm and TSS is less than 20 mg/l.
- Runoff from rehabilitated areas of South Pit is directed to SD 9, SD 10, SD 11, SD 12 and SD 13 for settling. The dams and drainage on the rehabilitated surface that direct water to the sediment dams are designed to minimise erosion and deposition whilst flowing. The dams are passive management systems, overflowing when runoff volumes exceed the available storage.
- Sewage from the CHPP and Workshop/Office is treated in a packaged treatment plant and sent to the Waste Water Dam for disposal by irrigation. The plant is operated under an Approval to Operate issued annually by Singleton Council.
- Waste hydrocarbons are separated out from the workshop water stream and removed from site by a licenced contractor.

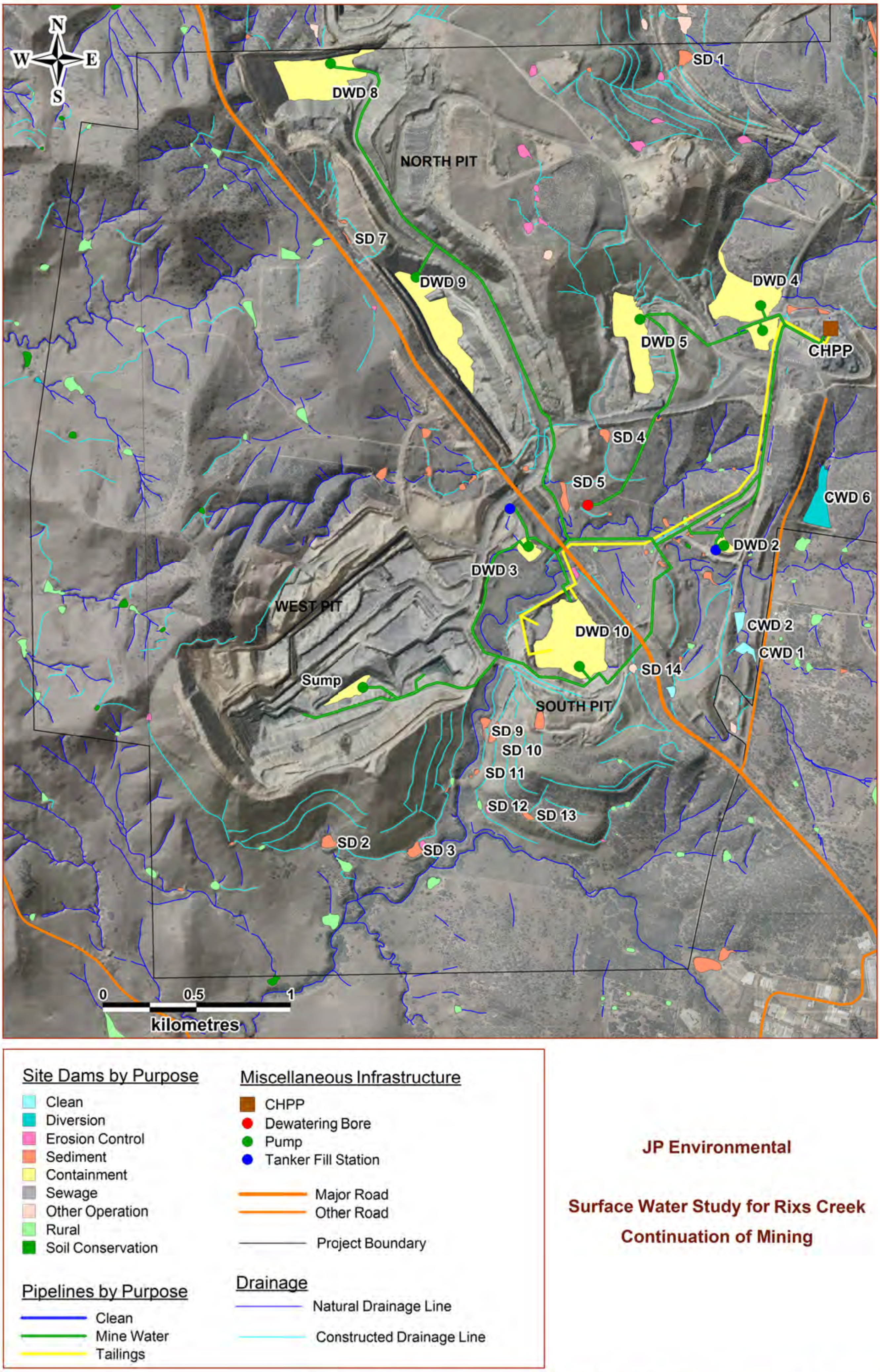
Appendix D: Dam Stage-Storage-Area Curves sets out the capacities of the main mine water storages on site.

3.8.4 Tailings Management

Current tailings management is a combination of pumping thickened tailings slurry to DWD 9 and haulage of tailings cake to overburden emplacements. By 2015 the CHPP will have changed completely over to the tailings decanter centrifuge system which dewaters the tailings at the CHPP. The tailings cake contains negligible free water; it is spadeable and quite easily handled. The dewatered tailings cake is disposed separately or mixed with coarse reject and disposed of in overburden emplacements using trucks.

Tailings dams are only be required as an emergency disposal option for unscheduled maintenance. A 40 ML emergency tailings dam would provide adequate capacity for a month of tailings production at current ROM tonnages.

Water recovery from tailings is expected to rise from 14% to 45% of the water in pumped tailings, reducing CHPP water demand from 258 l/tonne (ROM) to 75 l/tonne. This equates to a 1.2 ML/day reduction in CHPP water demand at 2014 production rates. The increased water recovery from adopting the tailings centrifuge dewatering system is expected to go some way to offsetting the reduced yields from future diversions of rehabilitated catchments.



JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 18: Site Layout of 2014 Water Management System

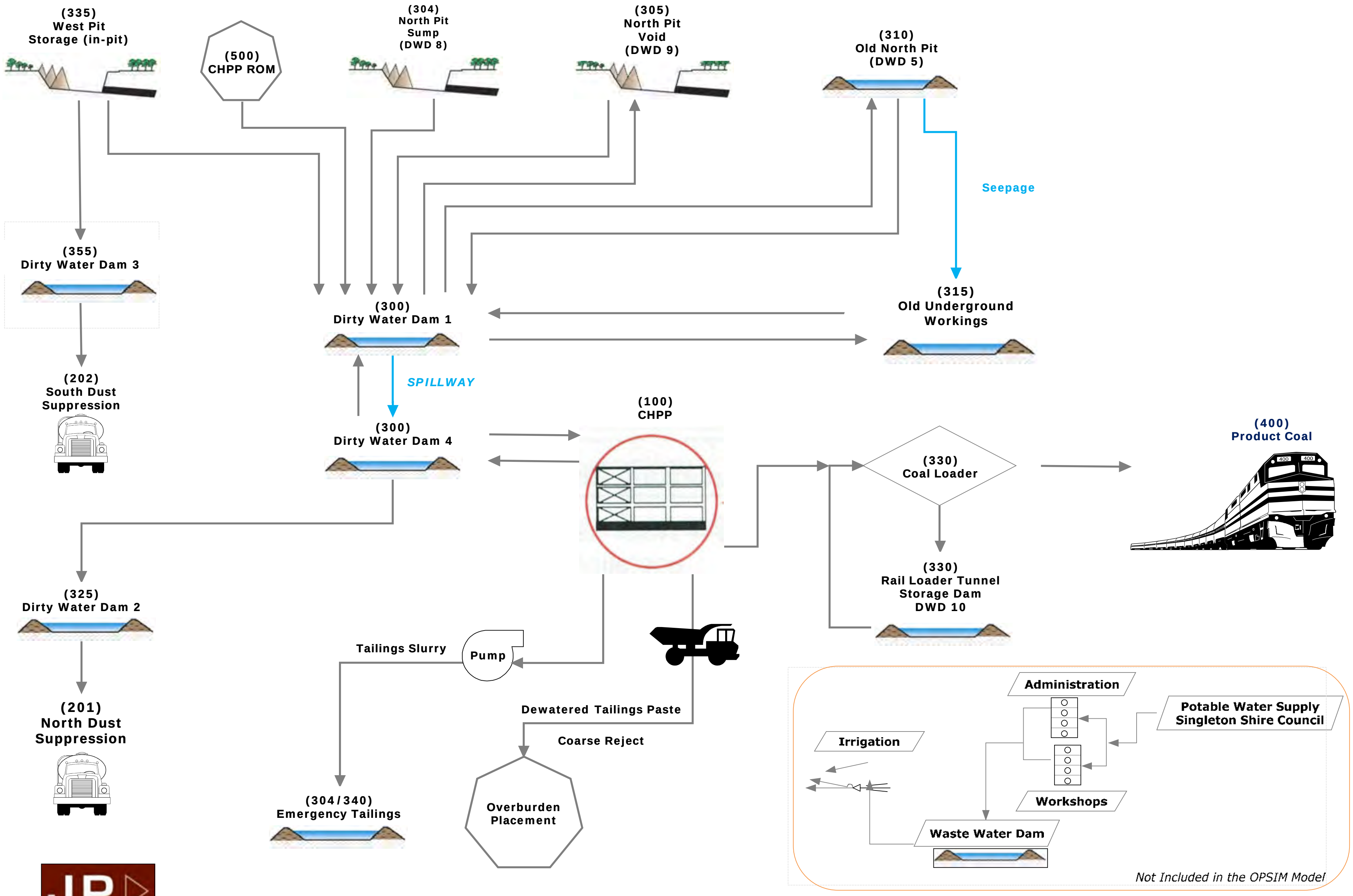


Figure 19: System Schematic for Rixs Creek OPSIM Model 2014 - 2022

4.0 Water Management System

4.1 Water Management and the Mine Plan

Water management system layouts are overlain on shaded relief maps of the conceptual mine plan for years 2014, 2017, 2020, 2023, 2026 and 2036 on **Figure 18** and **Figure 20 to Figure 24**. Catchment maps of the proposed mine footprint are provided for the above mining scenarios are shown on **Figure 25** to **Figure 29**

During 2014, coal mining operations cease in the North Pit. Mining advances to the north at West Pit and overburden emplacements behind West Pit are progressively constructed and rehabilitated. By 2017, the western out of pit (WOOP) overburden emplacement is opened in the area shown as "Pit 3 – North – Sediment" on **Figure 26**. Overburden will be placed in the area between DWD 8 and DWD 9 at North Pit but will not achieve final landform by 2017. Dewatering of the South Pit Tailings Dam commenced in 2014, and rehabilitation of this area may be completed by 2017 even though **Figure 26** conservatively shows the area is still a contained catchment. Surface drains at South Pit will be directed to existing sediment dams progressively as the landform is reconstructed. Tailings dewatering will switch completely to a tailings decanter centrifuge system and DWD 9 will act as an emergency tailings dam. Tailings cake will generally be mixed with coarse reject and hauled to purpose built emplacements for burial in the overburden.

From 2017 to 2019 overburden is placed behind the advancing West Pit into the WOOP. Filling and reshaping of the North Pit landform is substantially completed by 2020. Mine water pipelines from the West Pit to the CHPP dams will be relocated to provide shorter pumping routes where and to be constantly visible. Increased mining depths will likely require stage pumping to dewater the West Pit at an acceptable rate. A fresh water pipeline may be installed from the Hunter River to DWD 3; the notional pipe route is shown on **Figure 24**. The surface configuration of the mine water dams is unchanged, but the open water capacity of DWD 9 will be considerably reduced by overburden placement and it will primarily act as an emergency tailings dam. Excess mine water will be stored on the surface primarily in DWD 1, DWD 4, DWD 5 and DWD 8; and subsurface in the old workings and in pore space in the overburden draining to DWD 8 and DWD 5. The proposed subsurface storage locations are shown on **Figure 32**. Surface drainage will be progressively installed and directed to new sediment dams as shown on **Figure 20**.

By 2023 the outer face of the emplacements behind the advancing West Pit are substantially complete; the North Pit landform is complete except for the sump at DWD 8 – refer **Figure 22** and **Figure 28.** North Pit surface drainage is directed north to Station Creek catchment via sediment Dams SD 1 and SD 8; and south to Rixs Creek via SD4 and SD 5. The WOOP overburden emplacement has reached the maximum footprint and sediment dams SD16 – 20 are all operational.

By 2023, only a remnant of undisturbed catchment remains in the West Pit footprint. The North Pit Void, DWD 9, is backfilled and the main spoil storage inventory is by now managed using DWD 8. DWD 5 will act as an emergency tailings dam.

By 2026 the West Pit highwall abuts the New England Highway and all external surface drainage is in place. The pipeline network is essentially unchanged from 2023. Saleable production is more or less consistent at around 1.2 mtpa until 2031 then falls away to around 0.5 mtpa by 2035 when mining has recommenced in North Pit in the vicinity of Stonequarry Gully. Mining continues to 2037 under this consent after which underground mining assumed to be ongoing. After 2036 DWD 8 is filled; the old underground workings are no longer used for water storage, and DWD 5 is consumed by mining shortly thereafter.

4.1.1 Mine Water Management System

The development of the water management system is summarised here, and is set out on **Figure 18** and **Figure 20 to Figure 24.** The mine water system is shown system schematics **Figure 19**, **Figure 33** and **Figure 34**.

For the majority of the mine life, West Pit dewatering is primarily focussed on delivering water to the CHPP dams DWD 1 and DWD 4. The CHPP draws water from DWD 1 and DWD 4 for Coal Preparation. Water from the CHPP Dams is pumped to the Old North Pit (DWD 5) to maintain an acceptable maximum operating level in DWD 1 and DWD 4. Surplus water can also be pumped to the old underground workings from DWD 5 and recovered via the same pipeline. Excess water from the CHPP and West Pit can be pumped to the North Pit Sump (DWD 8) and the North Pit Void (DWD 9) if DWD 5 cannot accept water. Water can be recovered from DWD 8 and DWD 9 to the CHPP Dams for use or transferred to DWD 5 during when water inventories become low.

Liquid tailings disposal currently goes to DWD 9, but from 2015 to 2022 tailings will only be pumped to DWD 9 when the tailings decanter centrifuge is under maintenance or in an emergency. DWD 5 will act as the emergency tailings dam from 2023 until 2036, after which the West Pit final void will be used.

By 2023 DWD 8 and DWD 9 will be backfilled with spoil. A sump will remain open at DWD 8 to allow water to be pumped in and out of the residual subsurface spoil void storage. DWD 8 sump is planned to be backfilled with mined overburden from West Pit at the latest by 2036. If water storage space is still required after this date, the option remains to install a water recovery system, such as a large diameter well during the backfilling of DWD 8.

The old underground workings will be consumed by mining by 2036 and the DWD 5 shortly after, by which time the West Pit final void will be available for emergency tailings disposal and storage of mine water.

Water will be pumped to DWD 2 from the CHPP dams for use in dust suppression via water carts. DWD 3 water tanker fill station will be supplied from West Pit or DWD 2. DWD 3 will be consumed by mining after 2020 and the water cart fill station will be relocated, a notional relocation near the Highway underpass is shown on **Figure 22**, **Figure 23** and **Figure 24**.

4.1.2 Erosion and Sediment Control

Erosion and subsequent release of sediment off site has the potential to adversely affect the ecological and geomorphological values of the receiving streams. Suspended sediments can increase turbidity, transport nutrients, metals and toxicants into the receiving streams, placing pressure on existing flora and fauna communities. Transport and deposition of coarser sediments can change the cross sections of streams changing the geomorphology.

Sediment control measures for the Project will be designed on the basis of ensuring that runoff from disturbed areas is separated from clean and dirty runoff areas and directed to sediment settling dams for treatment. Design of erosion and sediment control measures will be based on the recommended design standards in the following guidelines:

- Managing Urban Stormwater, Soils & Construction, (Landcom, 2004).
- Managing Urban Stormwater, Soils & Construction, Vol. 2E Mines & Quarries (DECC, 2008).
- Managing Urban Stormwater, Soils & Construction, Vol. 2C Unsealed Roads (DECC, 2008a).

Figure 20 to Figure 24 show existing and proposed locations for sediment control dams and surface drains on the Mine. The surface drainage network shown on the figures is designed based on the concept mine plans. The drain grades are generally set at 1% grade to minimise the risk of ponding from overburden settlement and to still remain flat enough to avoid erosive velocities. Some lined drains will be required to convey water directly down the slope.

It is expected that up to eight long term sediment dams may be required to collect runoff from disturbance related to mining and from overburden emplacement areas: SD 8 and SD 21 at North Pit; and SD 15 – SD 20 at West Pit.

Even though an appreciable number of the receiving streams around the site are 3rd or 4th order, in terms of habitat, ecological studies indicate they can be classified as Class 4 or Class 3 streams, i.e.

unlikely or minimal habitat for fish or invertebrates, and not considered a sensitive receiving environment, hence 85th percentile rainfall has been adopted for sizing sediment control dams.

Dam Design

Sediment dam sizes and locations will be confirmed during detailed design based on final catchments which may vary from the conceptual mine plan. Based on the concept mine plans, the sediment dam sizes have been estimated in this report (Refer **Table 11**), based on the following design standards and methodology:

- Catchment soils were assumed Type D (dispersive) as no soil tests have been taken from within the catchments indicate otherwise.
- The total sediment basin volume will be the sum of the settling zone volume and the sediment storage volume.
- A sediment basin spillway capacity of 100 year AEP peak discharge to protect against structural damage.
- The sediment basin settling zone volume based on 85th percentile 5-day duration rainfall of 27.5 mm estimated from the Jerrys Plains Post Office daily rainfall record with an adopted volumetric event runoff coefficient for disturbed catchments of 0.56. The runoff coefficient assumes the period of disturbance will be between 1 and 3 years.
- The sediment storage volume is based on Revised Universal Soil Loss Equation calculations.
- The sediment storage zone is sized to contain the volume of sediment generated from the catchment over a 1 year period
- Appropriate release structures will be incorporated into new dams.

Sediment Dam Management

The operational management of the sediment dams will ultimately depend on the design of the sediment storage zone and the design rainfall adopted when the proposed dams are installed. Sediment dams 9 to 13 are located on mature rehabilitation and are unlikely to require any management unless additional disturbed areas are directed to them as drainage is designed for the rehabilitation of Pit 2. For the remaining sediment dams, the adopted management protocols will depend on the design criteria at the time of installation/upgrade.

Based on the dams as described in **Table 11** and sized as described in the section Dam Design, above the following general management protocols will be adopted:

- The sediment storage zone in each dam will be marked by pegs or similar so that the remaining capacity of the zone can be determined by inspection.

- After runoff events, if water levels are above the sediment storage zone level, the water storage will be flocculated, settled and drained within 5 days. The dam water level will be lowered to at least the top of the sediment storage zone.
- Water will not be discharged to the receiving catchment unless TSS levels are less than 50mg/l. Turbidity measurements may be used as an analogue for TSS once a reliable relationship between the two analytes can be established.
- If discharge is not practical due to water quality or other issues, the water will be recovered into the mine water management system within the 5 days required by the Blue Book.
- The sediment storage zones are designed to fill in 12 months. Sediment dams will be desilted every 12 months unless inspections indicate otherwise. Desilted material will be placed and dried and buried in areas that are internally draining.
- Water samples from selected sediment operational sediment dams will be tested annually as per

4.1.3 Clean Water Management

There may be opportunities to divert clean water in front to the advancing West Pit. However there will be close interactions between land disturbance and any clean diversion water system from 2017 onwards. Consideration of the catchment sizes and the soil types indicate that the least risk management methodology would be to combine the sediment affected and clean water flows and direct all flows through SD 20. This is the current practice, with clean and disturbed catchments in advance of West Pit being directed to SD 5.

Table 11: Conceptual Sizes for Sediment Dams

Dam No.	Status	Final Catchment Area (ha)	Capacity (ML)
SD 1	Existing	70	17
SD 2	Existing	113	26
SD 3	Existing	48	13
SD 4	Existing	116	27
SD 5	Existing	158	25
SD 6 - SD 7	Existing	65	16
SD 8	Proposed	96	27
SD 9	Existing	18	5
SD 10	Existing	25	7
SD 11	Existing	0.7	0.5
SD 12	Existing	7.3	2
SD 13	Existing	36	6
SD 14	Existing	28	5
SD 15	Proposed	3.4	2
SD 16	Proposed	63	15
SD 17	Proposed	72	17
SD 18	Proposed	137	32
SD 19	Proposed	12	3
SD 20	Proposed	14	4
SD 21	Proposed	61	17

4.1.4 Contaminated Water Management System

The approved Mine site facilities may produce runoff that contains hydrocarbons. These areas include:

- The vehicle and equipment wash-down area.
- Workshop.
- Fuel, oil and grease storages; and
- Refuelling bays.

Runoff from these areas on the mine site facilities will be managed as follows:

- Runoff will drain to a triple interceptor (or similar) to reduce hydrocarbons to acceptable levels before draining to the downstream dams. The oily fraction would enter a containment system for removal as necessary.
- Storage tank areas would have an impermeable surface and bunding capable of containing 110% of the largest tank's capacity.
- All oil, grease, fuel and hydrocarbon products would be securely stored.
- Refuelling, oiling and greasing would take place in designated areas only.

In event of a spill, the contaminated soil at the site of the spill would be collected and transported to a licensed waste disposal facility or remediated safely onsite.

4.1.5 Potable Water

Potable Water on the Mine is supplied via a pipeline from Singleton Shire Council. The current supply arrangement is proposed to be used for the Project.

As the existing Mine workforce will continue to be utilised there will be no increase in potable water required for the Project.

4.1.6 Water Management Storages

Table 12: Mine Water Storages provides details of the main mine water management storages within the study area including the sources of flows into and out of the storages. The catchment areas and land use draining to the various dams are given in **Appendix E**. The stage-storage-surface area of each dam is given in **Appendix D**. The dams are connected by a pipe network, which enables the transfer of water according to mine operational requirements.

No new large out of pit mine water dams are proposed for the project.

The only dams that have potential to spill off site into natural drainage due to embankment failure are DWD 2, DWD 10 and DWD 11. A preliminary assessment of the dams would suggest that the dams would be in the low or very low flood consequence category. There is no population at risk along Rixs Creek or Station Creek watercourses.

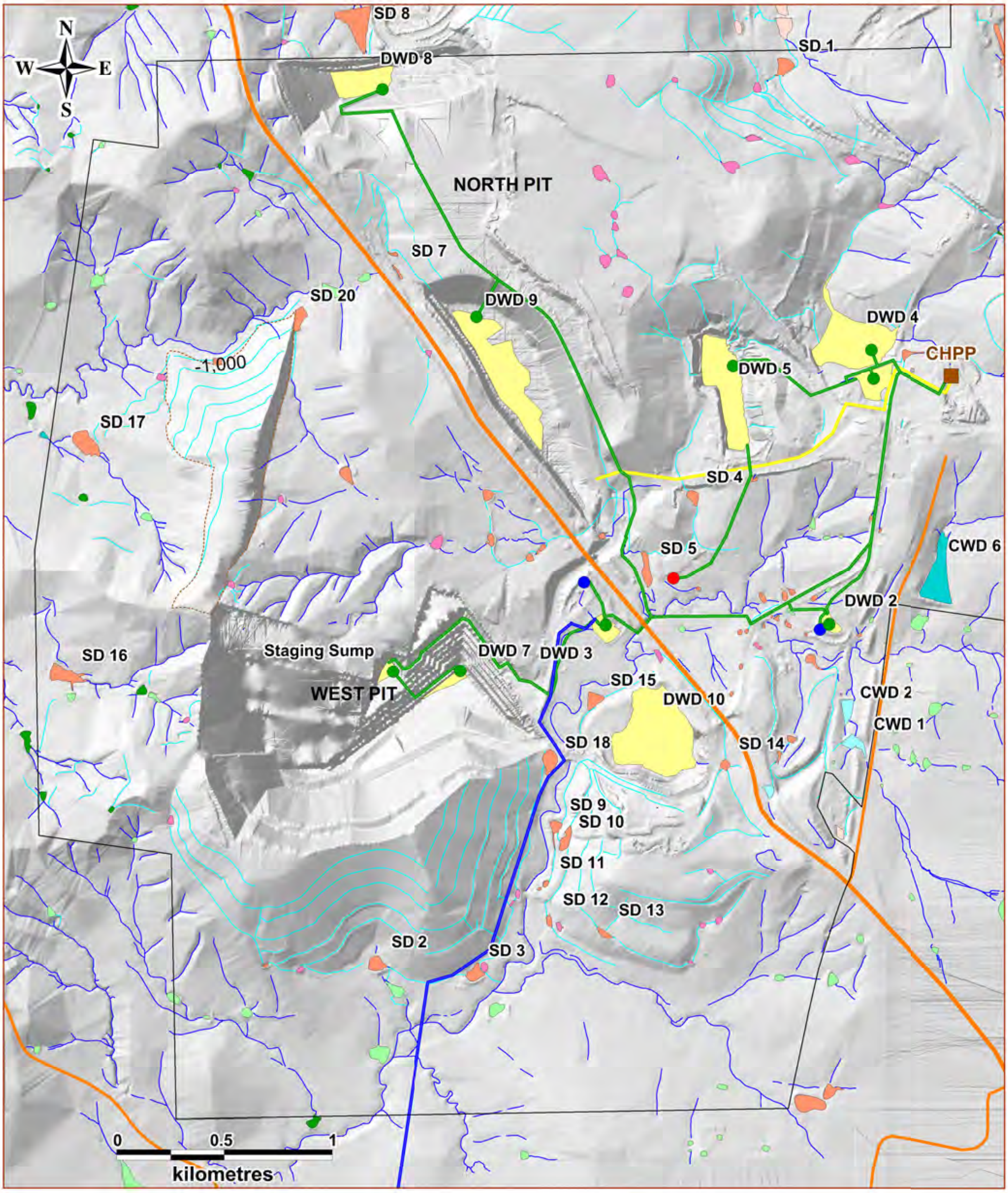
4.1.7 Final Landform

Figure 31 shows the configuration and drainage catchments of the final landform. The following drainage characteristics are proposed for the final landform:

- All erosion control drainage (contour drains, stilling dams etc.) and sediment dams in excess of harvestable rights requirements will be removed and rehabilitated. Only necessary erosion control structures will be retained.
- The upper southern and western face of the final void will drain off site to Rixs Creek.
- Clean Water Dam 6 will be retained for harvesting supply for the ongoing operation of the CHPP and Underground Mine (WAL 19024, WAL 19027).
- If required, pumps located on the Hunter River will be retained and operated to supply the ongoing operation of the CHPP and Underground Mine (WAL 11917, WAL 11918, WAL 11919)
- The final Void will operate as a water source and repository for fine and coarse reject.

Table 12: Mine Water Storages

No.	Name	Storage Capacity (ML)	Water Source	Water Use
DWD 1	Dirty Water Dam 1	28	o Pumped from DWD 4, 7 8 & 9 o CHPP and Industrial Area runoff	o Coal preparation o Wash down
DWD 2	North Water Cart Fill Station	10	o Pumped from DWD 1	o Dust suppression on haul roads
DWD 3	Dirty Water Dam 3	33.5	o Pumped from DWD 1 o Pumped from West Pit (DWD 7) o Disturbed catchment runoff	o Dust suppression on haul roads
DWD 4	Dirty Water Dam 4	335	o Clean water catchment runoff. o Pumped from DWD 5 o Spillway operation from DWD 1	o Pump to DWD 1 o Pump to DWD 5
DWD 5	Old North Pit	1,780	o Rehabilitated surface runoff o Pumped from DWD 4 o Pumped from Old Underground Bore	o Pump to DWD 4 o Pump to Old Underground
-	Old Underground Workings	650	o Pumped from DWD 5 o Seepage from coal seams	o Pump to DWD 5
DWD 7	West In-Pit Storage	7,400	o Mining areas and overburden runoff.	o Pump to DWD 1, 3, 8 & 9
DWD 8	North Pit Sump	4,217	o DWD 7 (West Pit) o Overflow DWD 9 o Overburden and coal contact runoff o Infiltration via overburden and rehabilitation.	o Pump to DWD 1
DWD 9	North Pit Void	2,253	o Tailings from CHPP o DWD 7 (West Pit) o Overburden and coal contact runoff o Infiltration via overburden and rehabilitation.	o Pump to DWD 1
DWD 10	Rail Loader Upper	38	o Coal contact runoff	o Stockpile - road dust suppression
DWD 11	Rail Loader Lower	5	o Coal contact runoff	o Stockpile – road dust suppression



Dams by Purpose
- Clean
- Diversion
- Erosion Control
- Sediment
- Containment
- Sewage
- Other Operation
- Rural
- Soil Conservation

Pipelines by Purpose
- Clean
- Mine Water
- Tailings

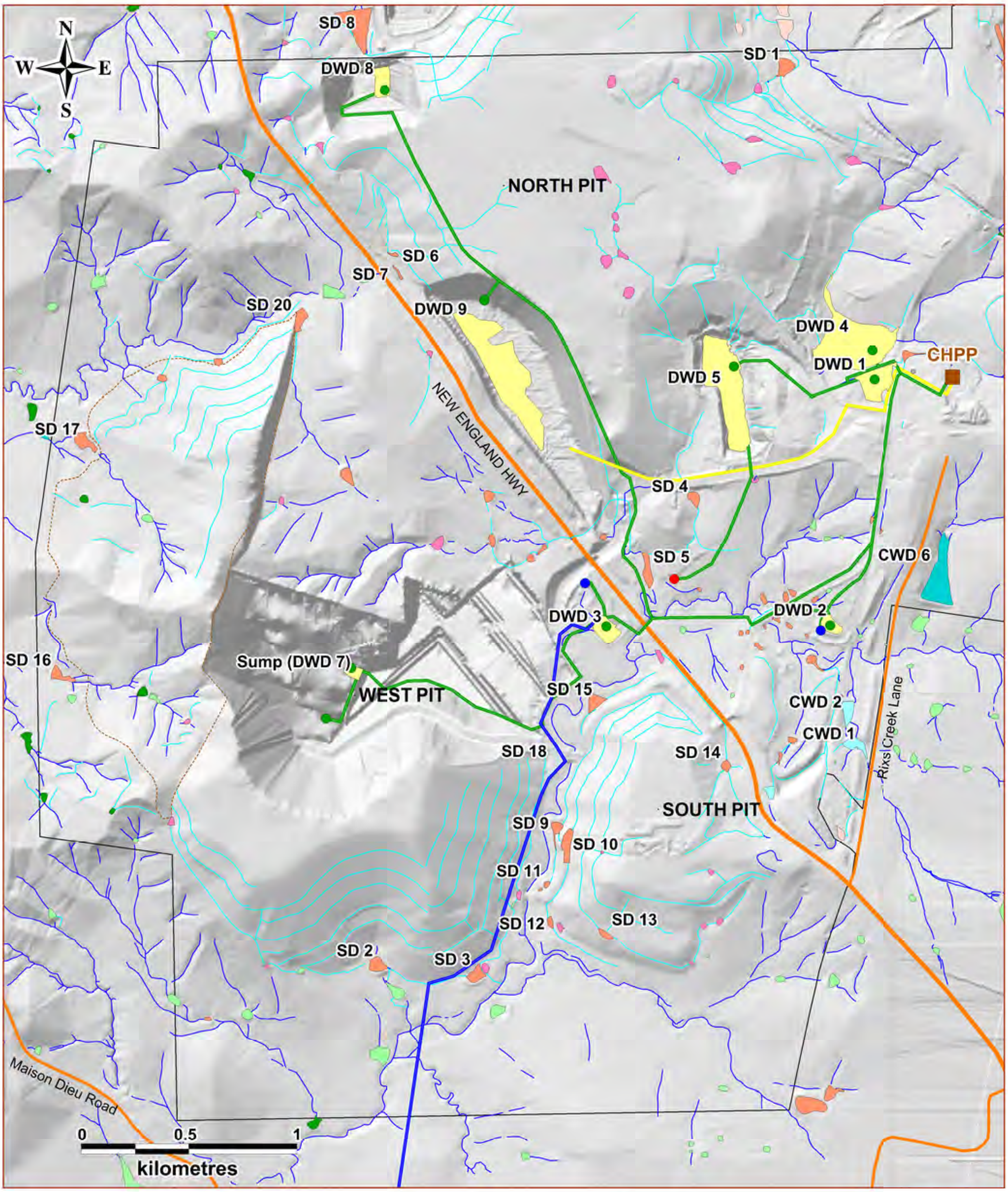
Other Infrastructure
- CHPP
- Dewatering Bore
- Pump
- Tanker Fill Station
- Major Road
- Other Road
- Project Boundary
- Emplacement Limit

Drainage
- Natural Drainage Line
- Constructed Drainage Line

JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 20: 2017 Water Management Layout



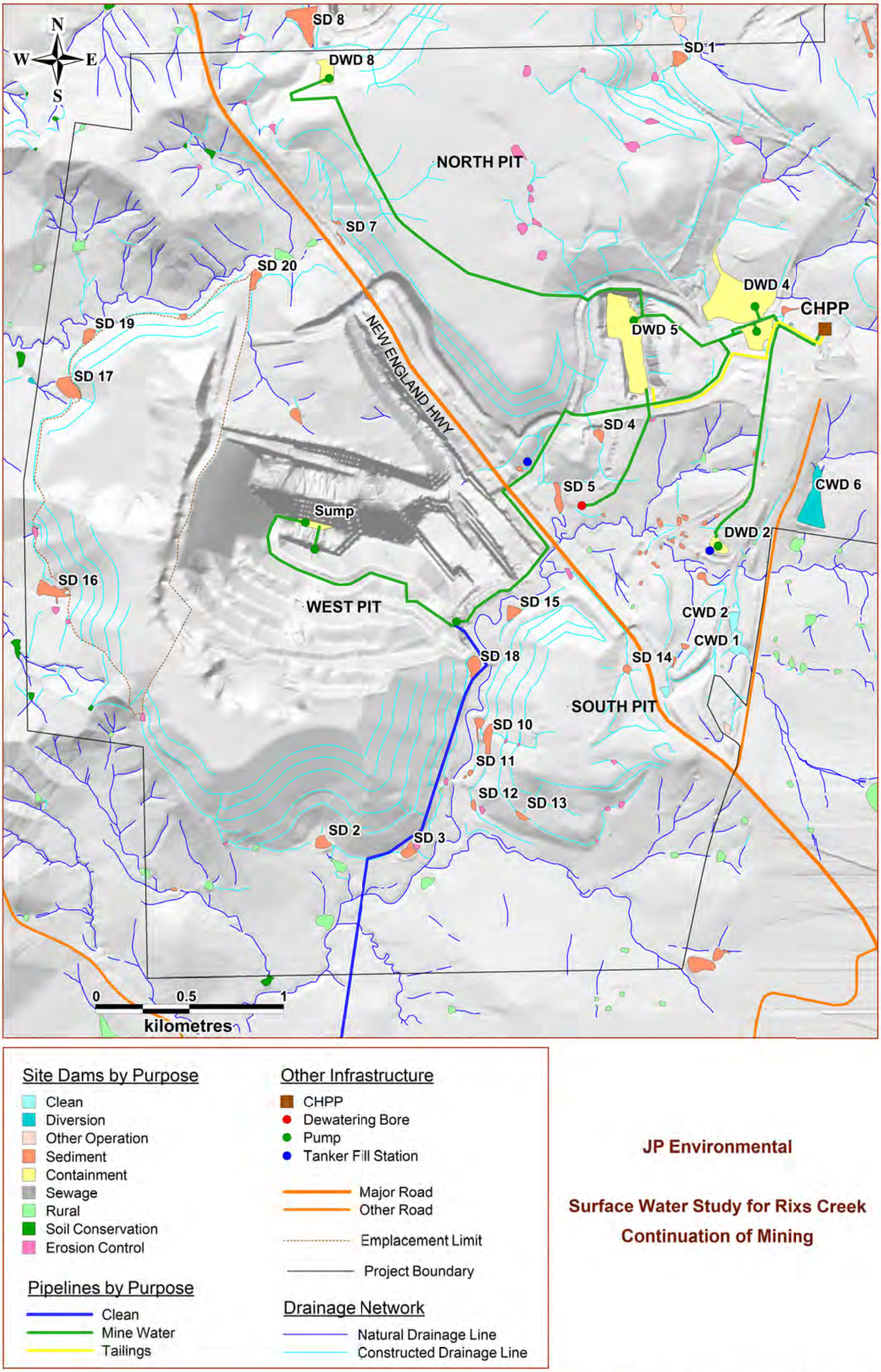
Site Dams by Purpose	Other Infrastructure
Clean	CHPP
Containment	Dewatering Bore
Diversion	Pump
Erosion Control	Tanker Fill Station
Other Operation	Major Road
Rural	Other Road
Sediment	Emplacement Limit
Sewage	Project Boundary
Soil Conservation	

Pipelines by Purpose	Drainage Network
Clean	Constructed Drainage Line
Mine Water	Natural Drainage Line
Tailings	

JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

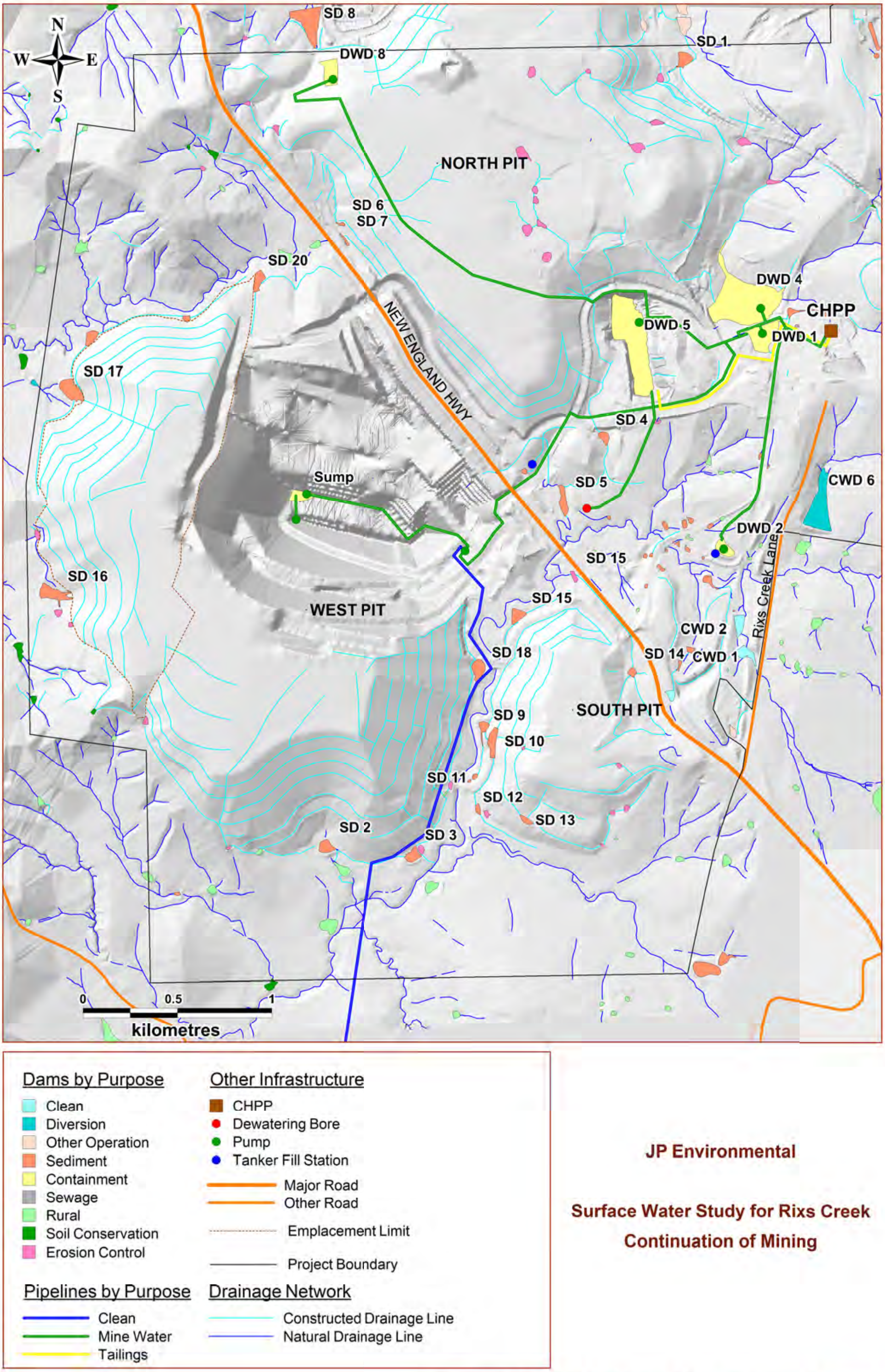
Figure 21: 2020 Water Management Layout



JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

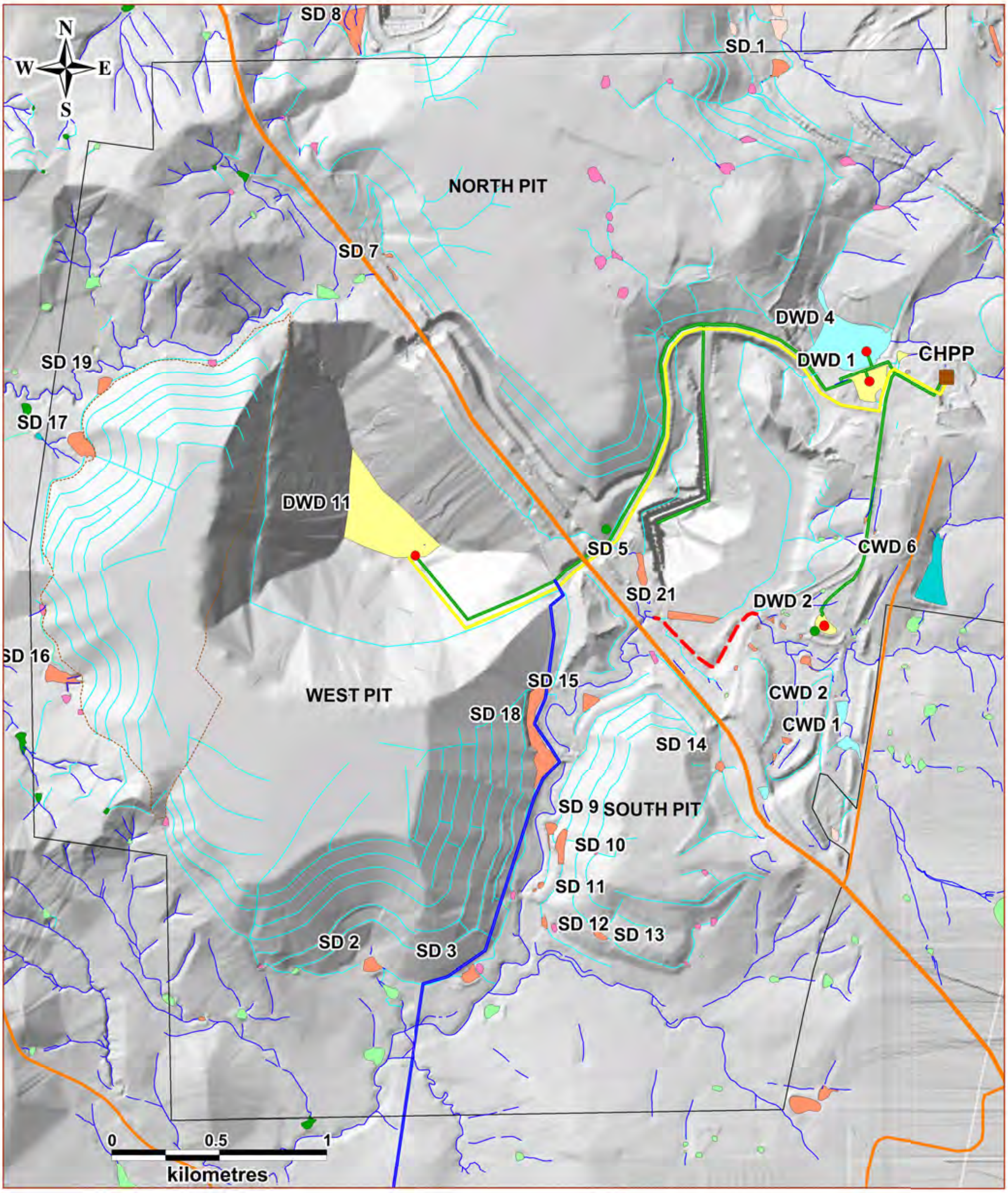
Figure 22: 2023 Water Management Layout



JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 23: 2026 Water Management Layout



Site Dams by Purpose

- Clean
- Diversion
- Other Operation
- Sediment
- Containment
- Sewage
- Rural
- Soil Conservation
- Erosion Control

Pipelines by Purpose

- Clean
- Mine Water
- Tailings

Other Infrastructure

- CHPP
- Pump
- Tanker Fill Station
- Major Road
- Other Road
- Project Area
- Emplacement Limit

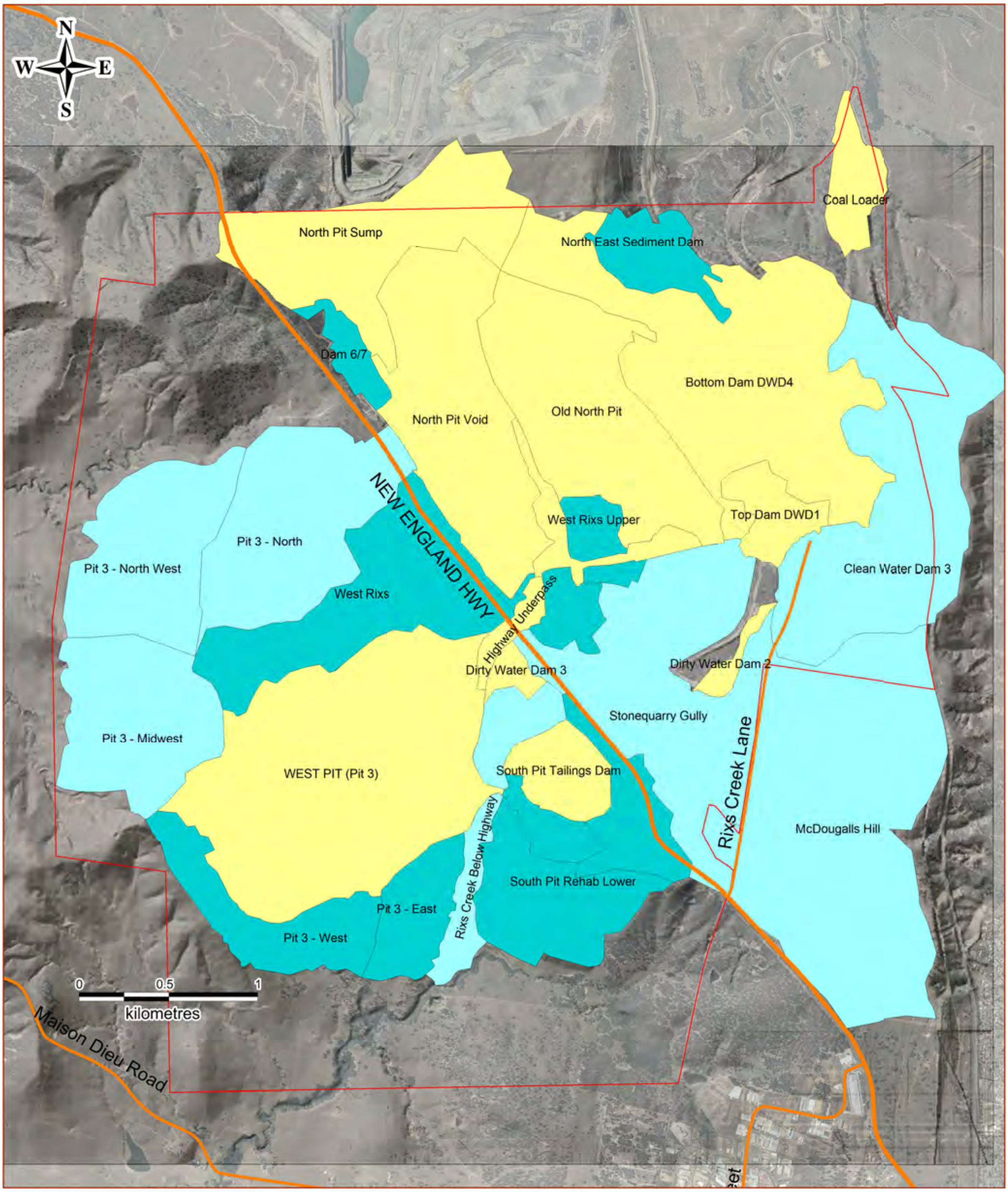
Drainage Network

- Constructed Drainage Line
- Stream Diversion
- Natural Drainage Line

JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 24: 2036 2036 Water Management Layout



Project Area

Project Boundary

Roads

Major Road

Other Road

Main Catchments by Quality

Saline

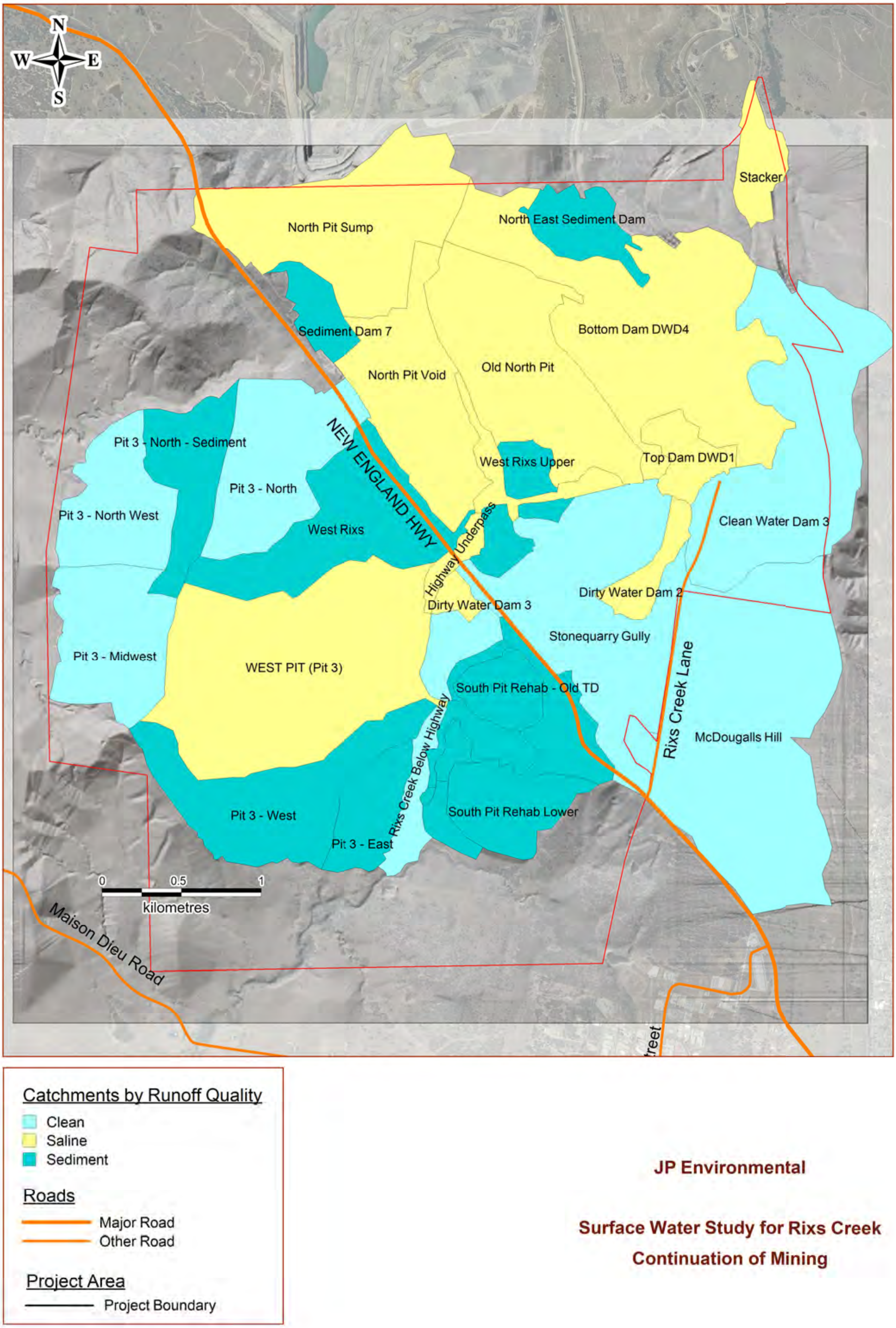
Sediment

all others

JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

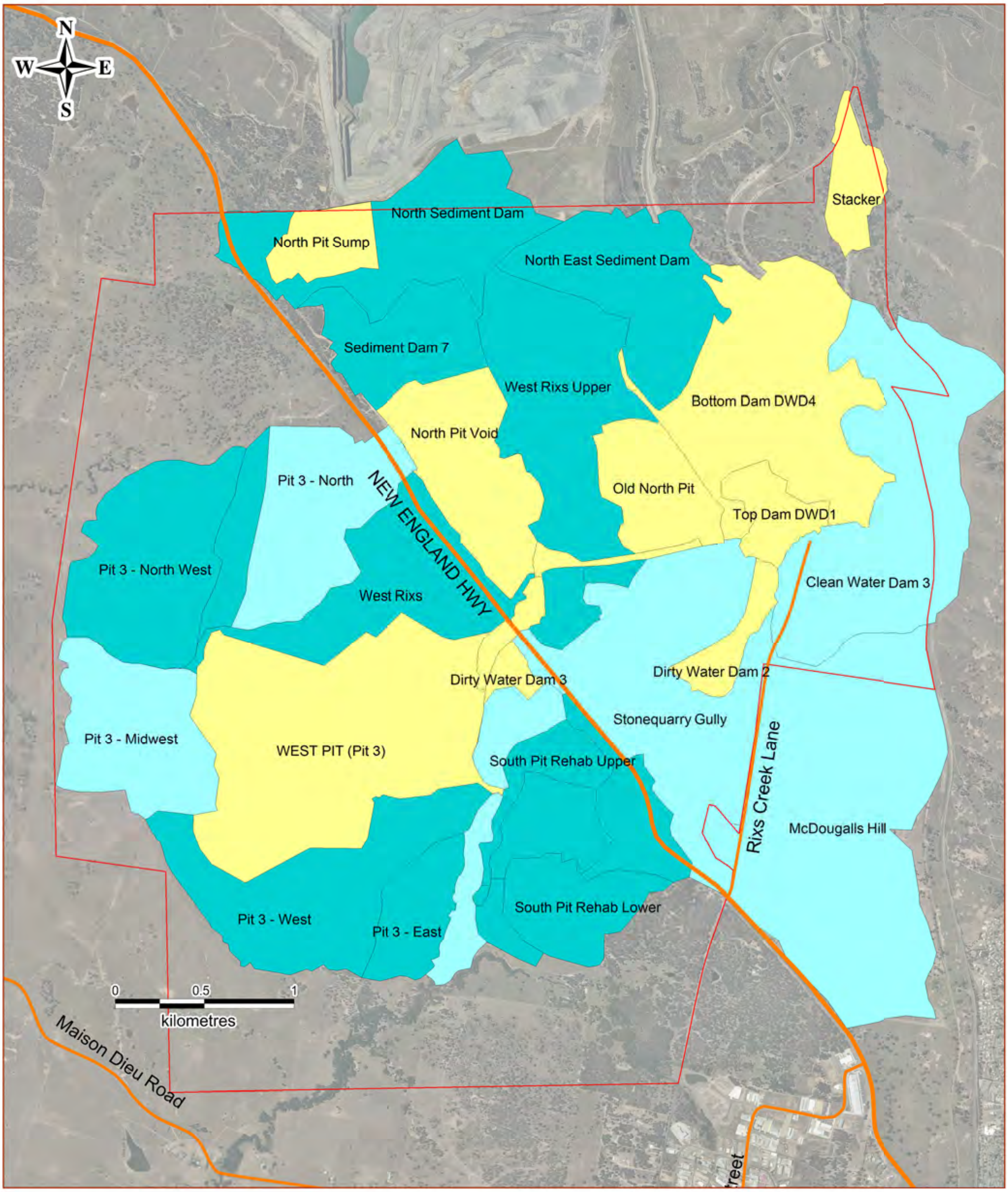
Figure 25: 2014 Catchment Plan



JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 26: 2017 Catchment Plan



Catchments by Runoff Quality

- Clean
- Saline
- Sediment

Roads

- Major Road
- Other Road

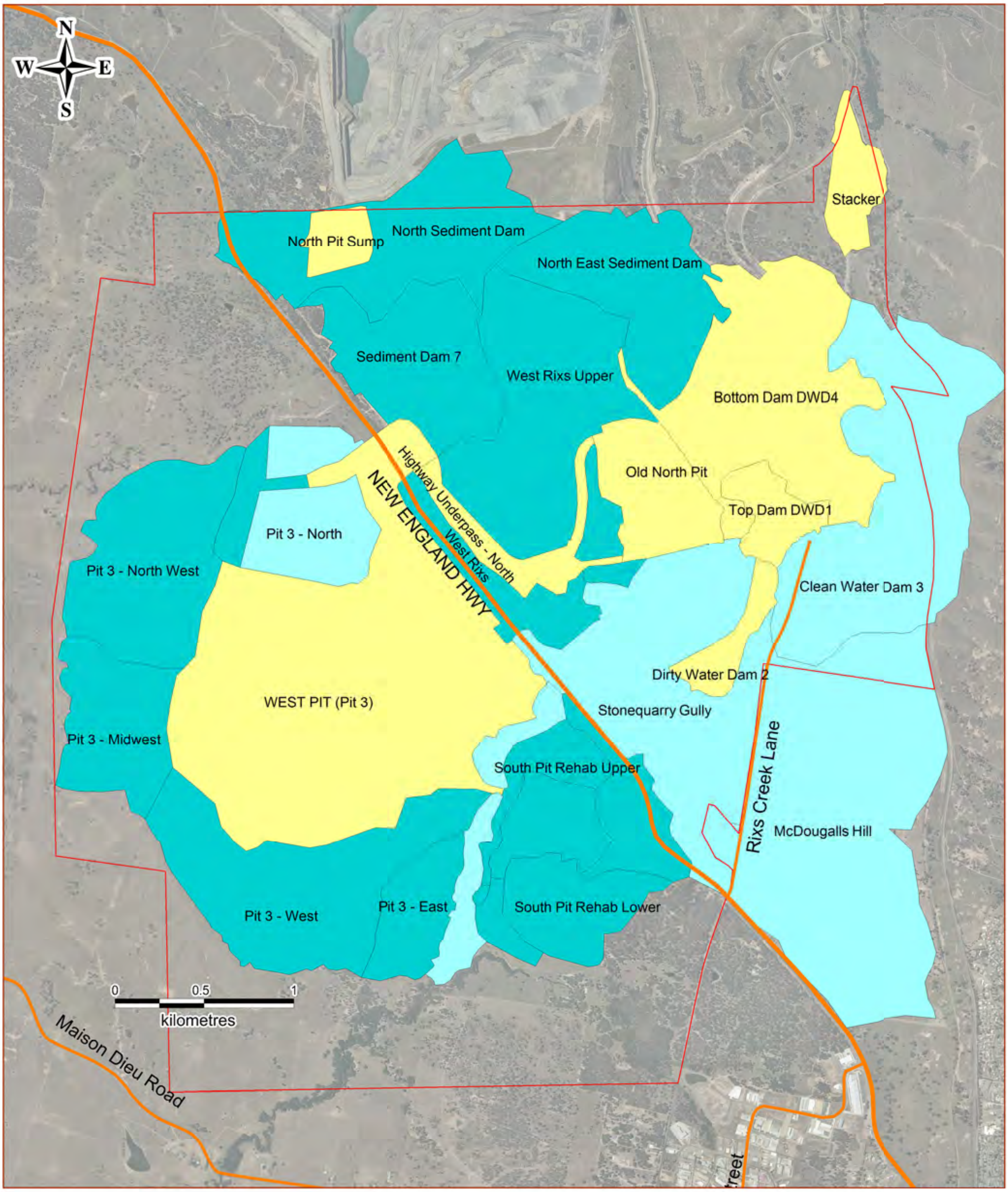
Project Area

- Project Boundary

JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 27: 2020 Catchment Plan



Catchments by Runoff Quality

- Saline
- Sediment
- all others

Roads

- Major Road
- Other Road

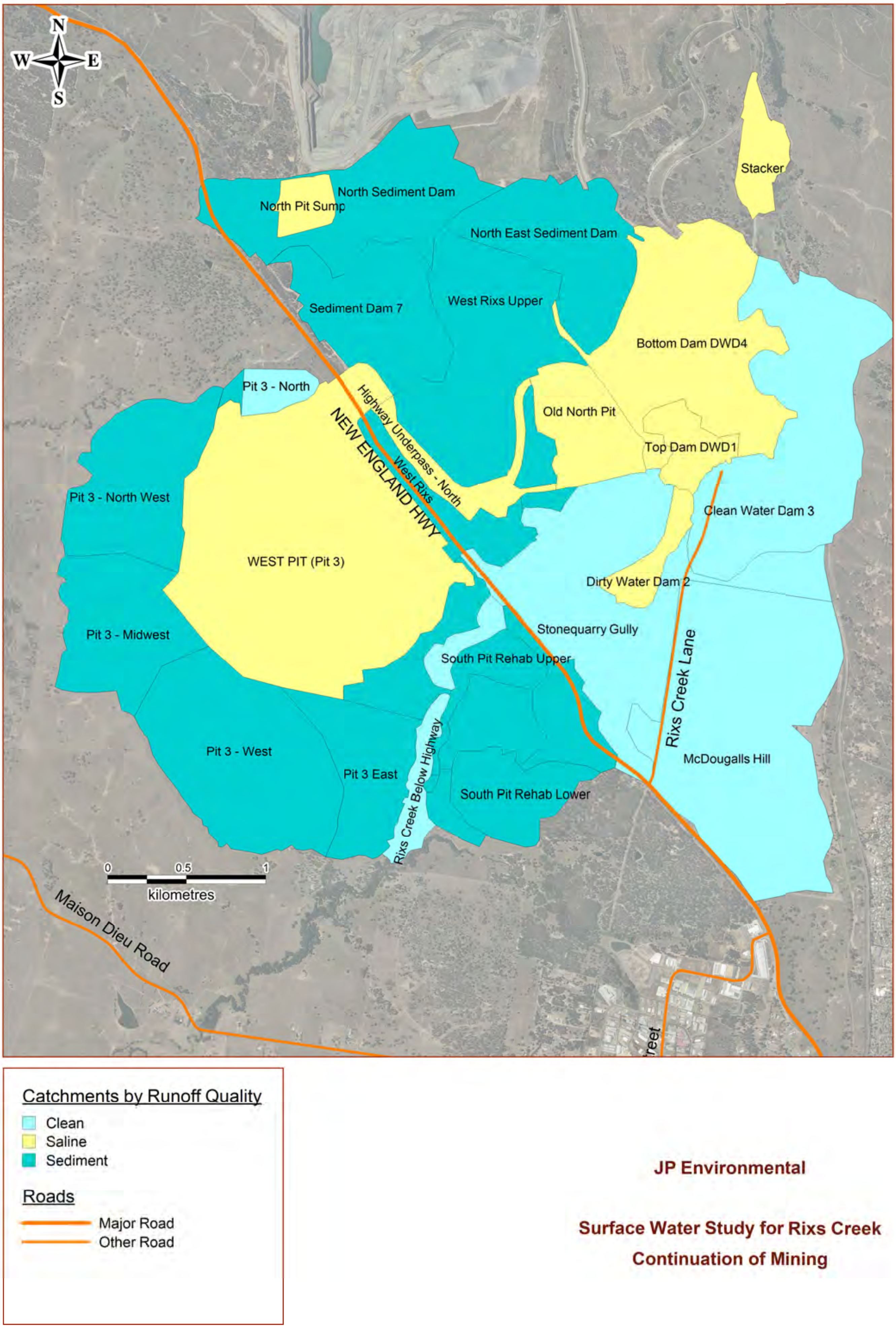
Project Area

- Project Boundary

JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

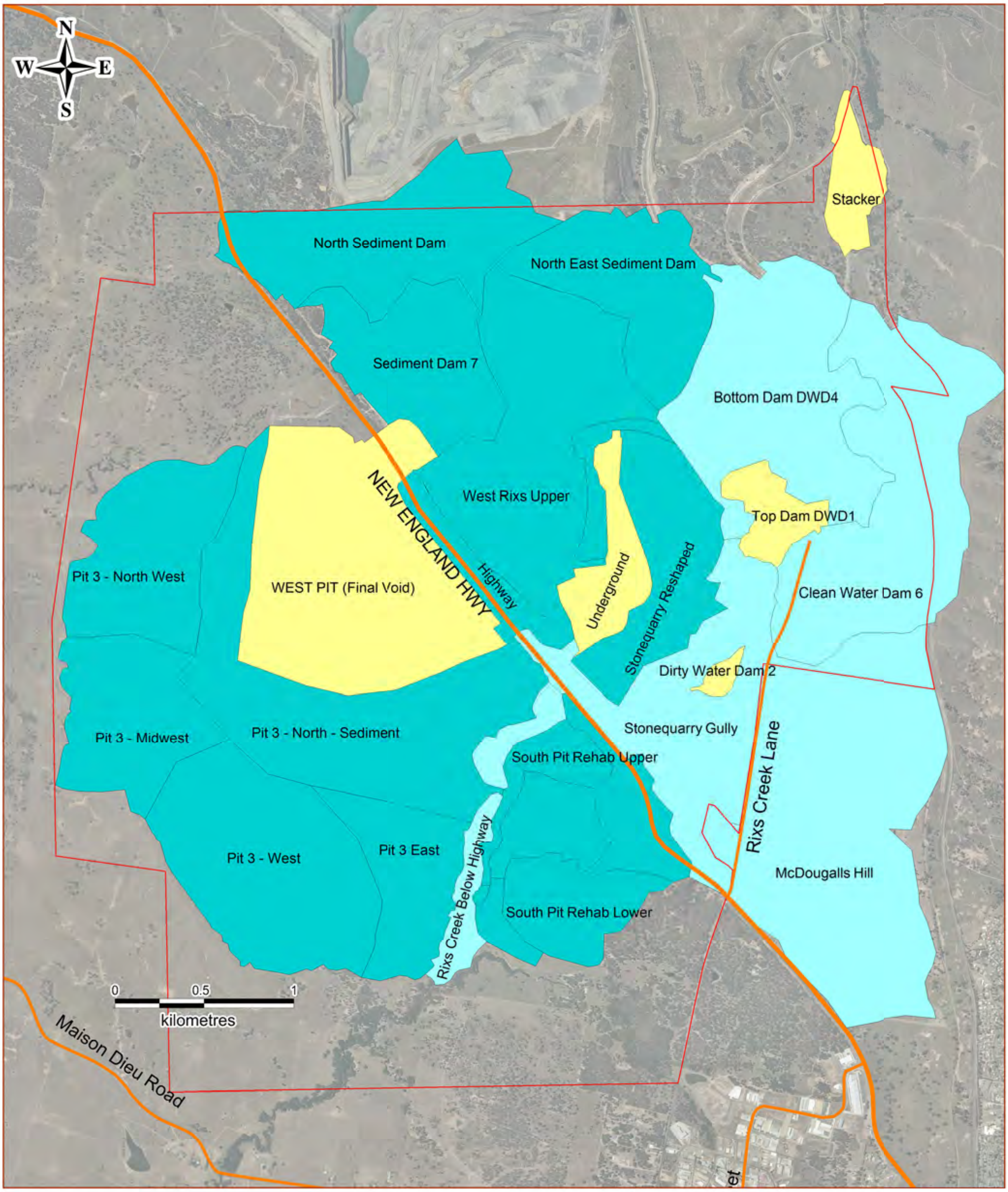
Figure 28: 2023 Catchment Plan



JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 29: 2026 Catchment Plan



Catchments by Runoff Quality

- Clean
- Saline
- Sediment

Roads

- Major Road
- Other Road

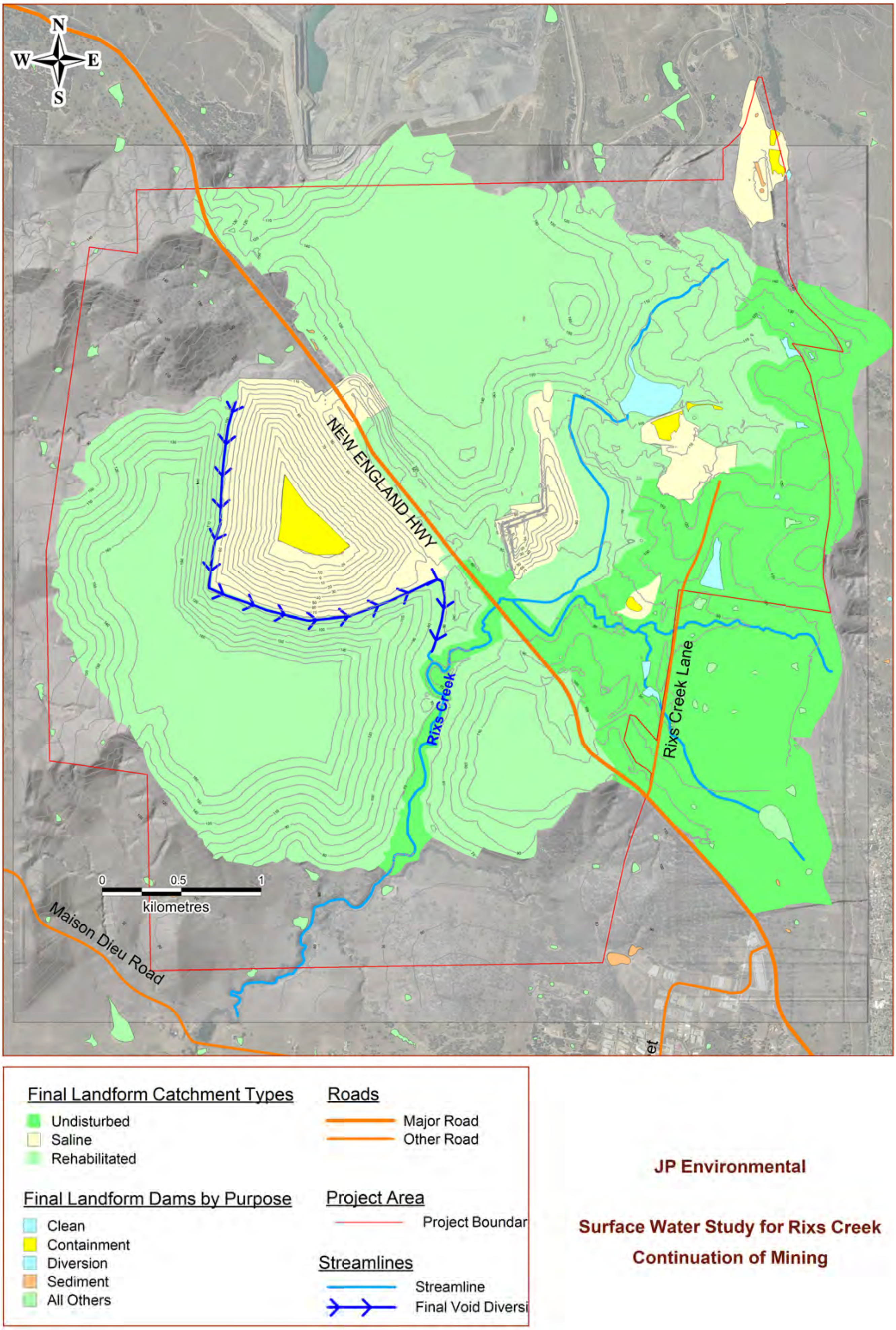
Project Area

- Project Boundary

JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

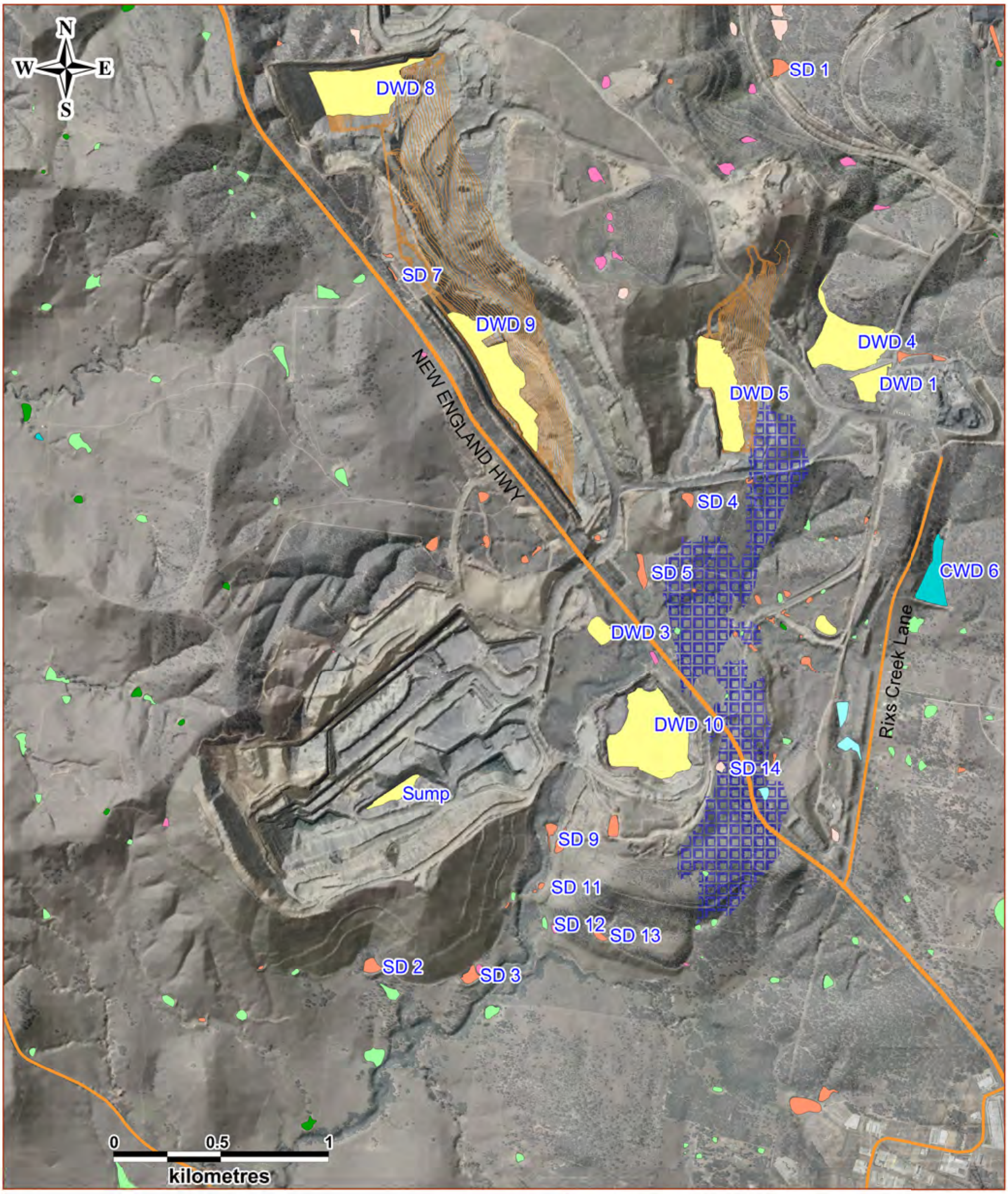
Figure 30: 2036 Catchment Plan



JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 31: Final Landform



2014 Dams by Purpose

- Clean
- Containment
- Diversion
- Erosion Control
- Other Operation
- Rural
- Sediment
- Sewage
- Soil Conservation

Extent of Spoil Storage

- Contour - Pit Floor

Old Workings

- Extent of Underground Workings

JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 32: Extent of Subsurface Storage

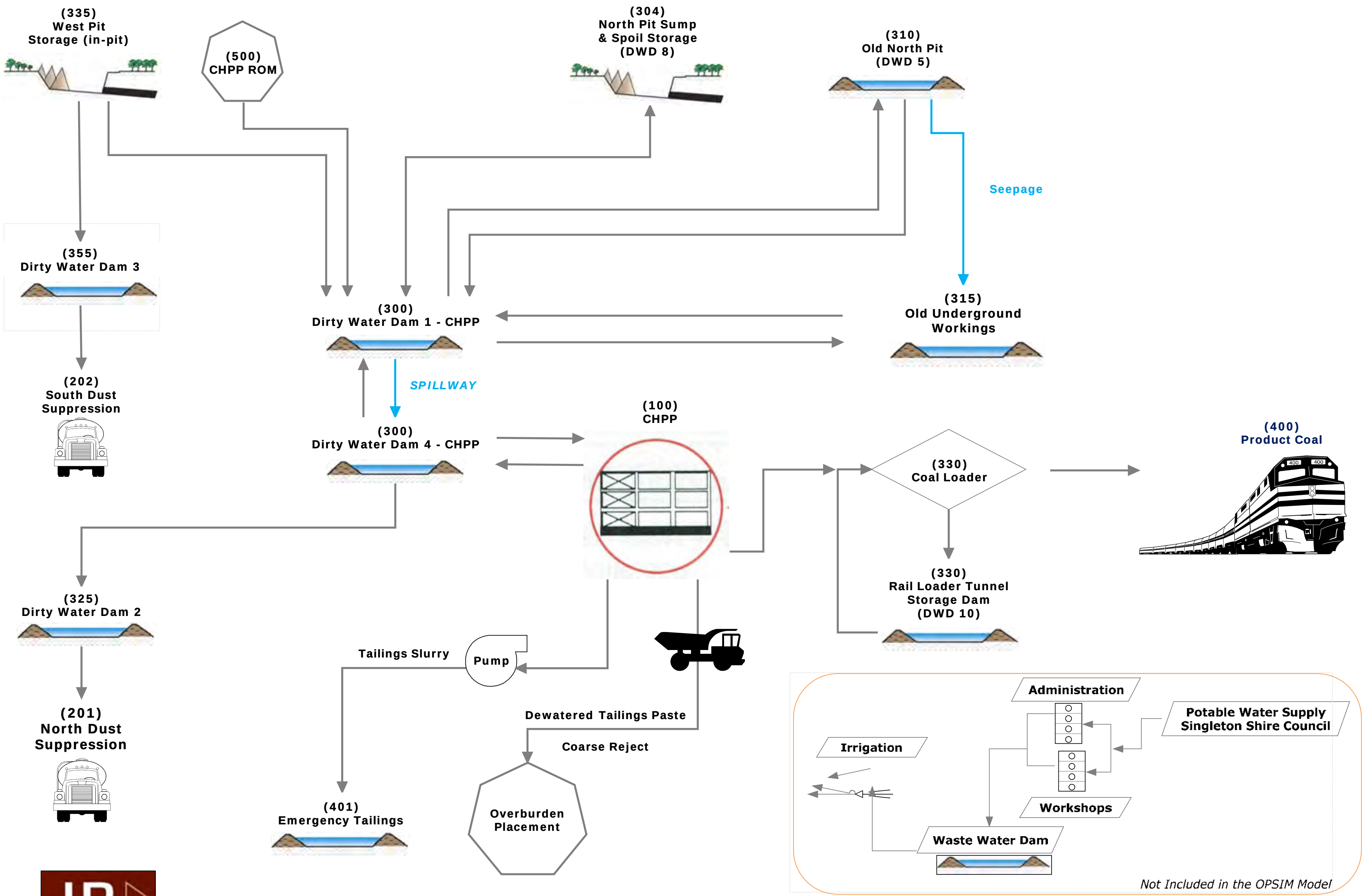


Figure 33: System Schematic for Rixs Creek OPSIM Model 2023 - 2036

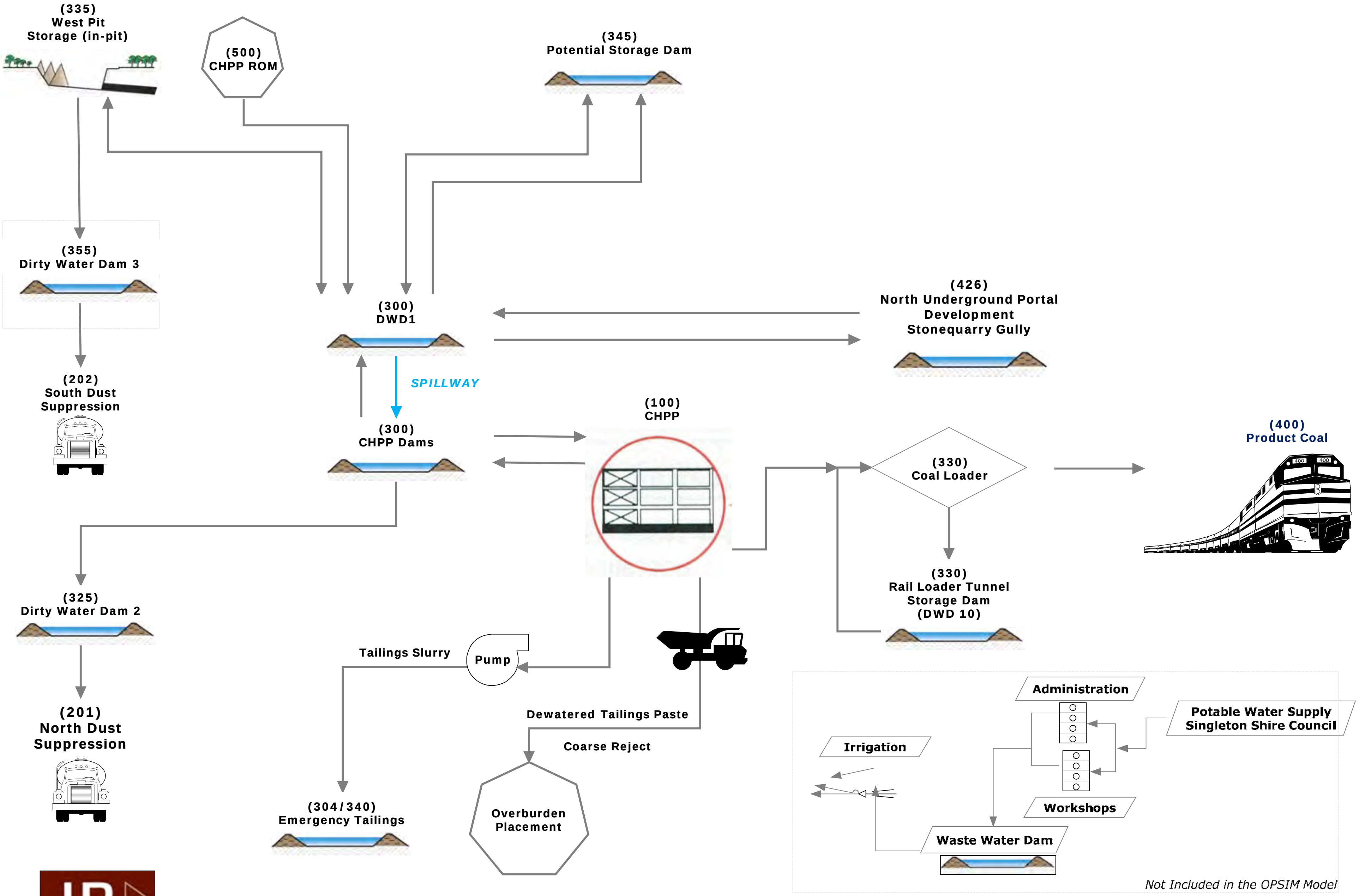


Figure 34: System Schematic for Rixs Creek OPSIM Model 2037 - 2041

5.0 Water Balance

5.1 Overview

The OPSIM computer-based simulation model was used to assess the dynamics of the water balance under conditions of varying rainfall, evaporation and catchment conditions within the study area. The OPSIM model works to dynamically simulate the operation of the water management system and in doing so keeps complete account of all site water volumes and representative water quality on a daily time step.

The model has been configured to simulate the operations of all major components of the water management system. The simulated inflows and outflows included in the model are given in **Table 13**.

Table 13: Simulated Inflows and Outflows to Mine Water Management System

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	CHPP demand
Groundwater inflows	Dust suppression demand
External water supply: Potable; Raw and Poor	Industrial use & vehicle wash down
ROM coal	Offsite spills from storages
	Controlled Releases under the HRSTS
	Product coal
	Moisture retained in washery rejects

5.2 Methodology

The OPSIM water balance model of the Rixs Creek Mine water management system, previously developed to assess prepare and maintain the Rixs Creek Water Management Plan (JP Environmental, 2009 and 2012), was used as the basis for the assessment. For this study, the runoff parameters in the OPSIM model were recalibrated to match recorded and storage volumes over the period 2007 to 2012. Details of the OPSIM model configuration and calibration is given in **Appendix A**. A description of the existing mine water management system is given in **Section 3.8**.

The calibrated model was updated to include conceptual mine plans out to 2042 and then run as a dynamic forecast simulation model. The model was run using synthesised climatic data from the SILO Data Drill service (Jeffrey et al. 2001). The Data Drill climatic data extends from 1st January 1889 to 31 December 2014, a period of 125 years. The dynamic configuration allows the simulation to change over the modelled Project life, reflecting changes in the water management system over time. Eight different stages of the Project were linked in the model to reflect variations over time such as catchments, ROM coal production, tailings management and groundwater seepage. The changes in the physical layout are represented in the mine stage plans given in **Figure 18** and **Figure 20** to **Figure 24**. Descriptions of the water management system over the life of the Project are given in **Section 4.0**. The operational rules and physical layout for each representative stage of mine progression were applied to a range of years given in **Table 14**.

Table 14: Representative Mine Stages

Representative Stage of Mining	Range
Year 1	2014 (1 year)
Year 2	2015 – 2016 (2 years)
Year 4	2017 – 2019 (3 years)
Year 7	2020 – 2022 (3 years)
Year 10	2023 – 2025 (3 years)
Year 13	2026 – 2031 (6 years)
Year 19	2032 – 2036 (5 years)
Year 24	2037 – 2041 (5 years)

Although the catchment areas will continuously change as the Mine is continually rehabilitated, the simplifications made by adopting the above stages in the model are expected to reasonably represent conditions over the 28 year period. The catchment areas draining to each mine water storage is given in **Appendix E**.

To assess the effects of varying climatic conditions, the model was run for multiple cycles with each cycle encompassing the Project life. A different rainfall input sequence was applied to each cycle by time stepping forward 1 year in the rainfall record for each cycle. Of the 125 years of historical climatic data available from January 1889 to December 2013, there are 97 “blocks” of data, each 28 years in length. The first “block” of data, from January 1889 to December 1916, is applied to the first cycle of the model. The second “block” of data, offset by one year, is then applied from January 1890 to December 1917 to the second cycle. Each subsequent cycle of the model has the rainfall data offset by one year, until the mine water system has been tested for 97 cycles against 125 years of rainfall data. A statistical analysis of the 97 cycles can then be undertaken to assess the behaviour of the various storages over extended dry and wet periods.

The adopted rainfall sequence for the simulations was based on a synthetic rainfall data set interpolated from point observations by the Bureau of Meteorology (SILO Data Drill, Jeffrey et al., 2001). A comparison of SILO data against recorded site data is given in **Appendix A**.

The OPSIM model also undertakes a mass balance of salt loads in all of the major storages within the study area to enable an assessment of the long term build-up of salts.

5.3 Catchments and Land Use

The catchment areas reporting to the Mine surface water storages will change as the site evolves. The breakup of catchment types for the main storages in over the Mine life are summarised in **Appendix E**.

5.4 Water Requirements

5.4.1 Coal Handling and Preparation Plant

Table 15 shows the expected daily water balance at the CHPP averaged over the applied range of years for each mine stage given in **Table 14**, above. Water is required at the CHPP and industrial area for coal processing, wash down and other associated uses. The volume of water required at the CHPP is directly related to the annual forecast coal production tonnages. The following operational characteristics were used to estimate CHPP water requirements:

- Raw feed coal total moisture content: 7.5% w/w.
- Product coal total moisture content: 8% w/w.
- Rejects total moisture content: 18% w/w.
- Tailings total moisture content: 67.96 % w/w, Year 1.
- Tailings total moisture content: 30 % w/w, Year 2 - 28.
- Tailings split: 30% (ratio of fine rejects/total rejects using dry weights); and

- Plant efficiency: the projected ratio of product coal/raw feed (by dry weights) ranges from 61.2% to 55.8% over the 28 year mine life.

Table 15: CHPP Water Balance

	Representative Stage of Mining							
	2014	**2015**	**2017**	**2020**	**2023**	**2026**	**2032**	**2036**
ROM Coal, Av. (mtpa)	2.446	2.446	2.504	4.177	1.974	1.84	0.852	0.347
Product Coal, Av. (mtpa)	1.505	1.505	1.512	2.522	1.192	1.120	0.506	0.195
Plant Efficiency (dry weight)	61.2	61.2	60.1	60.1	60.1	60.5	59.1	55.8
Raw Feed Moisture (kL/d)	502.25	502.25	514.2	857.7	405.5	377.8	174.9	71.3
Coal Product Moisture (kL/d)	329.6	329.6	331.2	552.6	261.2	245.0	110.9	42.6
Coarse Rejects Moisture (kL/d)	369.4	369.4	389.1	649.0	307.0	283.0	135.5	59.7
Tailings Moisture (kL/d)	1,529.9	1,529.9	1,611.3	2,687.8	1,271.5	1172.1	561.2	247.3
CHPP Makeup (kL/d)	1,726.7	1,726.7	1,817.4	3,031.7	1,434.2	1322.3	632.7	278.4

Industrial water use was assumed to be constant at 80 kL/day throughout the life of the Mine. Coal stockpile dust suppression is assumed to be constant at 30 kL/day throughout the life of the Mine.

5.4.2 Haul Road Dust Suppression

Table 16 shows the predicted haul road dust suppression water requirements for each mine stage. The adopted haul road dust suppression demand at each stage is primarily dependent on the ROM tonnage. The following is of note with regards to haul road dust suppression rates:

- Dust suppression occurs at seasonally adjusted rates throughout the year for each mine scenario. The typical seasonal “shape” adopted is shown on **Figure 35**, determined from a little over one year of records at Rixs Creek and longer periods of record at other nearby mine sites.
- The adopted relationship between haul road dust suppression and ROM tonnage is shown on **Figure 36**. The data was determined from AEMR reported values between 2012 -2014 for a range of open cut coal mines in the Hunter Valley.
- No dust suppressant agent is planned to be used.

Table 16: Haul Road Dust Suppression Requirements

Demand (kL/d)	Representative Stage of Mining						
	2014	2017	2020	2023	2026	2032	2036
North (Pit 1)	181	185	264	156	148	86	90
West (Pit 3)	181	185	264	156	148	86	0

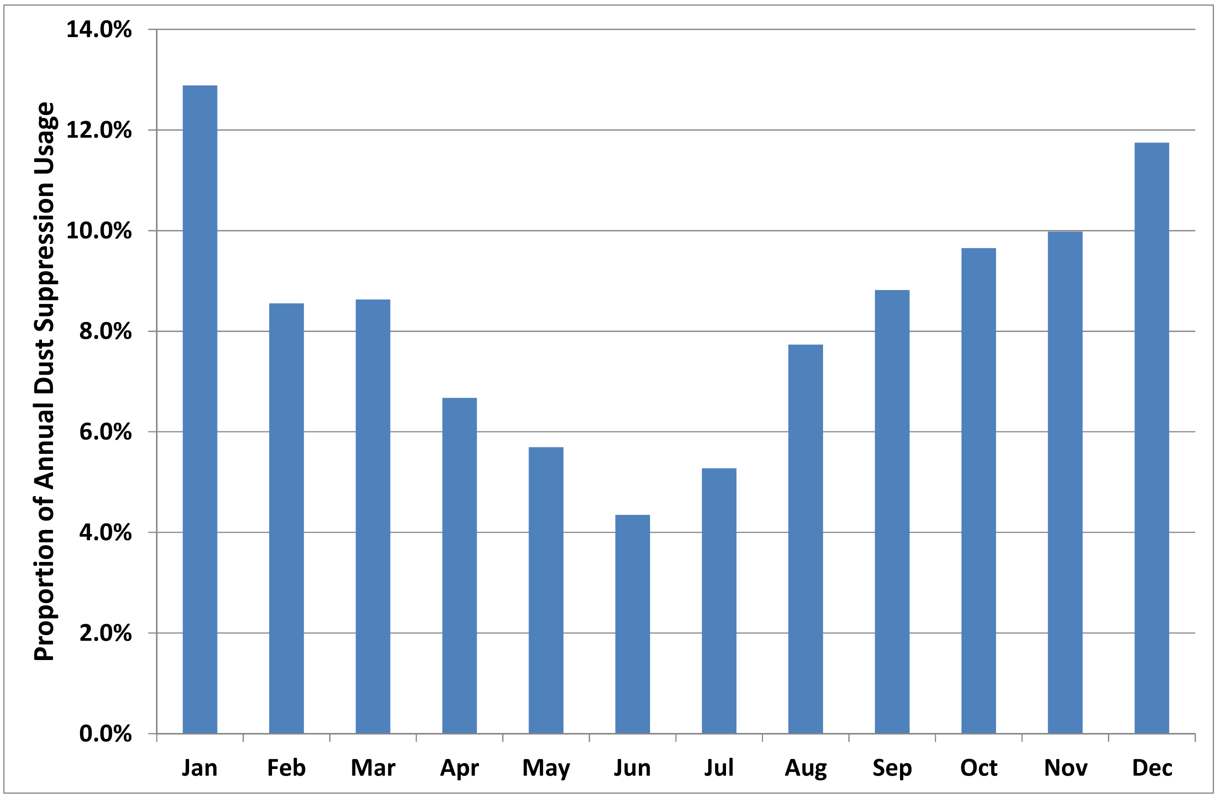


Figure 35: Seasonal Dust Suppression on Haul Roads

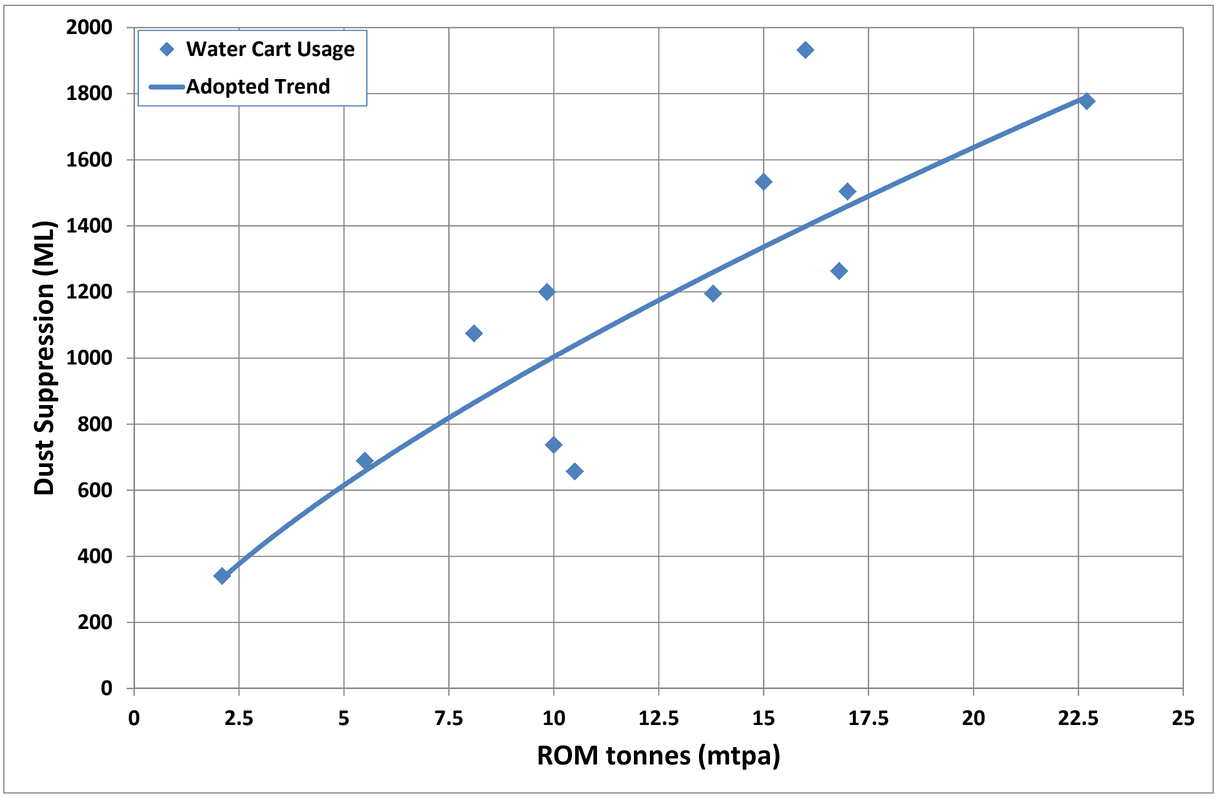


Figure 36: ROM Tonnage v Dust Suppression

5.4.3 Groundwater Inflows

Table 17 shows the estimated groundwater inflow to the three mining areas at the Mine over the life of the Project (RPS 2014). The adopted groundwater volumes are the estimated pumpable volumes after evaporation from the coal face is taken into account – about 25% of the required "licence" volume calculated for the groundwater study.

Table 17: Adopted Groundwater Inflows

Representative Stage of Mining	North Pit (Pit 1) Inflows (kL/day)	South Pit (Pit 2) Inflows (kL/day)	West Pit (Pit 3) Inflows (kL/day)
2014	30	1	130
2017	30	0	180
2020	30	0	190
2023	30	0	120
2026	30	0	110
2032	30	0	90
2036	100	0	19

5.4.4 Pump Inventory

Table 18 shows the adopted pump rates for transfers between storages. These rates have been are based on advice from site personnel and adjusted based on past experience with modelling open cut coal mines. Adopted pumping rates can have significant impacts on water residence time in pit and storages. For example if the adopted pump rate for dewatering a mine pit is too high, residence time in-pit is reduced and the risk of reduced pit workability will be underestimated.

Rules used to switch pumps on and off from the storages throughout the study area have been developed to either maintain a storage volume to enable supplies to be met or to prevent uncontrolled spills from occurring. The rules are generally based on the receiving storages ordering water to meet demand or to prevent an uncontrolled spill.

Table 18: Pumping Circuits

Pumping Circuit		Pump Rate		Comment
From	To	Inst. (l/s)	Daily (kL/day)	
West Pit	CHPP Dams	60	5,184	Supply on demand.
West Pit	North Pit & North Pit Void	60	5,184	Dewater as required.
North Pit & North Pit Void	CHPP Dams	60	5,184	Supply on demand.
Old North Pit	CHPP Dams	60	5,184	Supply on demand.
Old North Pit	Old Underground	60	5,184	As required.
Old Underground	Old North Pit	29	2,500	As required.
Coal Loader Dams	CHPP Dams	20	1,728	Bi-directional. As required.
CHPP Dams	Old North Pit	60	5,184	Dewater as required.
CHPP Dams	Dirty Water Dam 2	20	1,728	Supply on demand. Dust Suppression.
CHPP Dams	Dirty Water Dam 3	20	1,728	Supply on demand. Dust Suppression.
West Pit	Dirty Water Dam 3	60	5,184	Supply on demand. Dust Suppression.

5.5 Results

5.5.1 Overview

The OPSIM model was used to assess the performance of the proposed water management system (base case) against the following:

- Overall site storage inventory.
- Imported water supply requirements.
- Uncontrolled spills from the mine water storages; and
- The overall water balance within the study area.

A sensitivity analyses has been undertaken to assess the impact of increased haul road dust suppression.

In interpreting the results, the 50th percentile probability represents the 'most likely' scenario as it is the median result of all forecast simulations. The 10th and 90th percentile results represent reasonable wet and dry conditions over the simulation period. There is an 80% chance that the result will fall within this range. The 1st and 99th percentile results represent the likely upper and lower bounds of the estimate (i.e. 98% of all results will fall within this range).

It is important to note that investigation outcomes are dependent on the validity of the information on which the investigations were based. Although considerable care and attention has been paid to ensuring that base information is the best available, there is inherent variability with respect to some key site characteristics (e.g. catchment yield/rainfall runoff, mining area groundwater inflows, tailings return rates). Nevertheless, investigation outcomes are considered to be fair and reasonable, given the current status of base information.

5.5.2 Site Storage Inventories

Figure 37 to **Figure 40** show the confidence plots of total site water inventory, in-pit and out-of-pit storage volume on site over the 28 year life of the Project. A build-up of water in the active mining areas generally occurs when the out-of-pit storages are too full to accept additional water from the mining areas. **Figure 41** shows the performance of the North Pit Sump (DWD 8) a key sub-surface storage.

The out-of-pit storages include the CHPP Combined Dams (DWD 1 and DWD 4), North Pit and North Pit Void, the Old North Pit, the Old Underground Workings, the Coal Loader Dams and Dirty Water Dams 2 and 3. The out-of-pit storages have a combined capacity of approximately 9,500 ML at the start of 2014. The storages are kept below approximately 6,400 ML to prevent uncontrolled spills, making the effective out-of-pit storage capacity is about 6,400 ML.

The site water balance would generally be in equilibrium over the life of the Project when water in the out-of-pit storage under median (50%) conditions does not exceed 6,400 ML, to allow water to be pumped in from the active mining areas at all times. If the out-of-pit storage capacity exceeds 6,400 ML, mine pit workability could be affected.

The following observations are made:

1. For 50% of the time there will be negligible accumulation up of water in the active mining area of West Pit **- Figure 38**. Water held in the out-of-pit storages rises from approximately 2 ML to 3,500 ML when the West Pit final void is established in 2036, approximately 80 ML p.a. on average. From 2036 until 2041, West Pit acts as a final void and inventory increases from approximately 100 Ml to 3,600 ML.
2. The 10% confidence plot indicates there will be a maximum of around 4,000 ML held in the out-of-pit storages at some stage of the Project life – refer **Figure 40**. The 10% confidence plot on **Figure 38** indicates that inundation in the West Pit active mining area could reach a maximum of 1,300 ML around 2036 during the Project life, due to the out-of-pit storages being too full to accept additional inflows. Adverse conditions develop after 2032, about 19 years into the Project. There is 10% likelihood that an additional 1,300ML of out of pit storage may be required after this time.
3. The 1% confidence plot indicates that if extreme wet weather is sustained, the out-of-pit storages will reach the threshold at which water cannot be received by Year 2 of operations, and the storages would remain near that threshold for the entire Project life. Under these 1st percentile (very wet) conditions, mining area inundation would begin to accumulate from about 2015 onwards and the water in the West Pit would accumulate to a maximum of around 2,500 ML at the completion of open cut mining in 2036. Any water in excess of 500 ML in West Pit may significantly impact mining operations.
4. The results show that should 1st percentile, very wet conditions occur, the mine site storages are likely to be too full to accept pumped inflows from the mining areas from about 2016 onwards. Production will be impaired during these periods and an active mining area may need to be temporarily sacrificed for water storage. Should 1st percentile conditions occur early in the Project life, alternatives are to increase dust suppression watering rates or to construct an out of pit storage of at least 1,300 ML.
5. Under 90th percentile (dry) conditions it is likely that all accessible site storage will be consumed by the end of 2020, about 7 years into the Project. Water will need to be imported from external sources intermittently to meet CHPP and dust suppression requirements. An alternative to importing water may be adopt the use of dust suppressant chemicals to reduce water demand; and

6. There is a 1% chance, i.e. 99th percentile (very dry) conditions, that all accessible water will be consumed by the end of 2016, about 2 years into the Project. Water will need to be imported from external sources regularly to meet CHPP and dust suppression requirements. Alternatives to importing water are to adopt the use of dust suppressant chemicals to reduce water demand.

Figure 41 is a plot of the performance of the North Pit Void, a key storage in the site water management system. The North Pit Void and North Pit are mine voids that are proposed to be used as out-of-pit storage. The voids currently have a combined operational capacity of 5,800 ML. However this will be reduced to 4,600 Ml by the start of 2017 by overburden placement. After 2017 an open void will be retained at the North Pit for water management and storage capacity will remain constant until around 2036. The majority of storage capacity in the North Pit sump will be within the overburden pore space of North Pit and North Pit Void. About 423 Ml of dead storage will be created backfilling the North Pit Void due to a sill between the two voids, and this is evident in the plots on **Figure 37**, **Figure 40** and **Figure 41**.

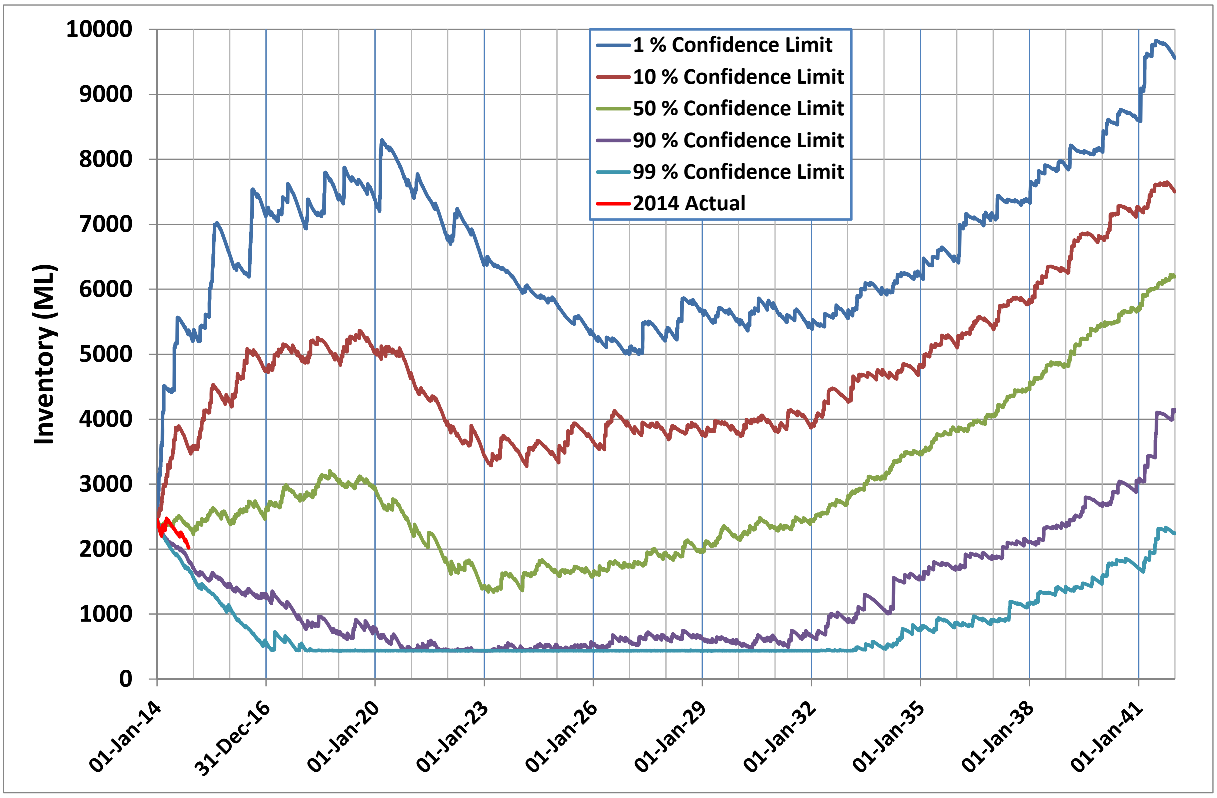


Figure 37: Forecasted Performance - Total Site Storage

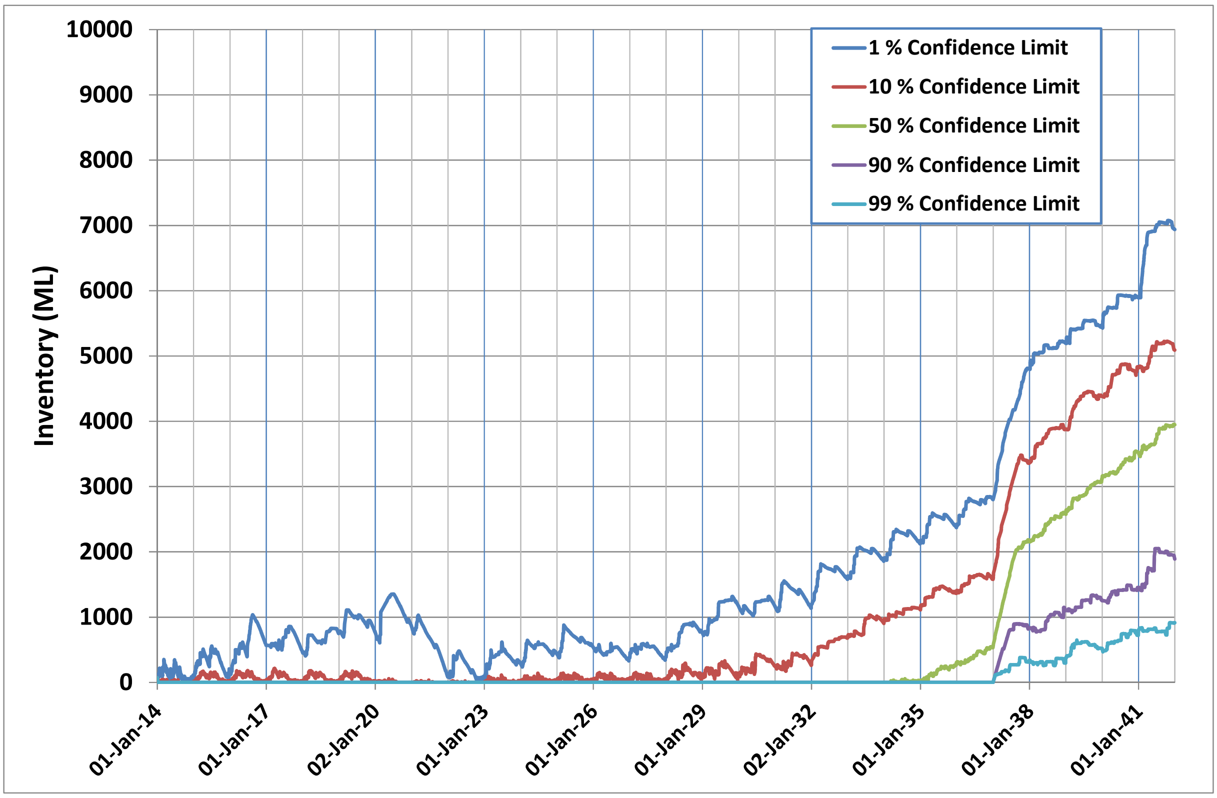


Figure 38: Forecasted Performance – West Pit Storage

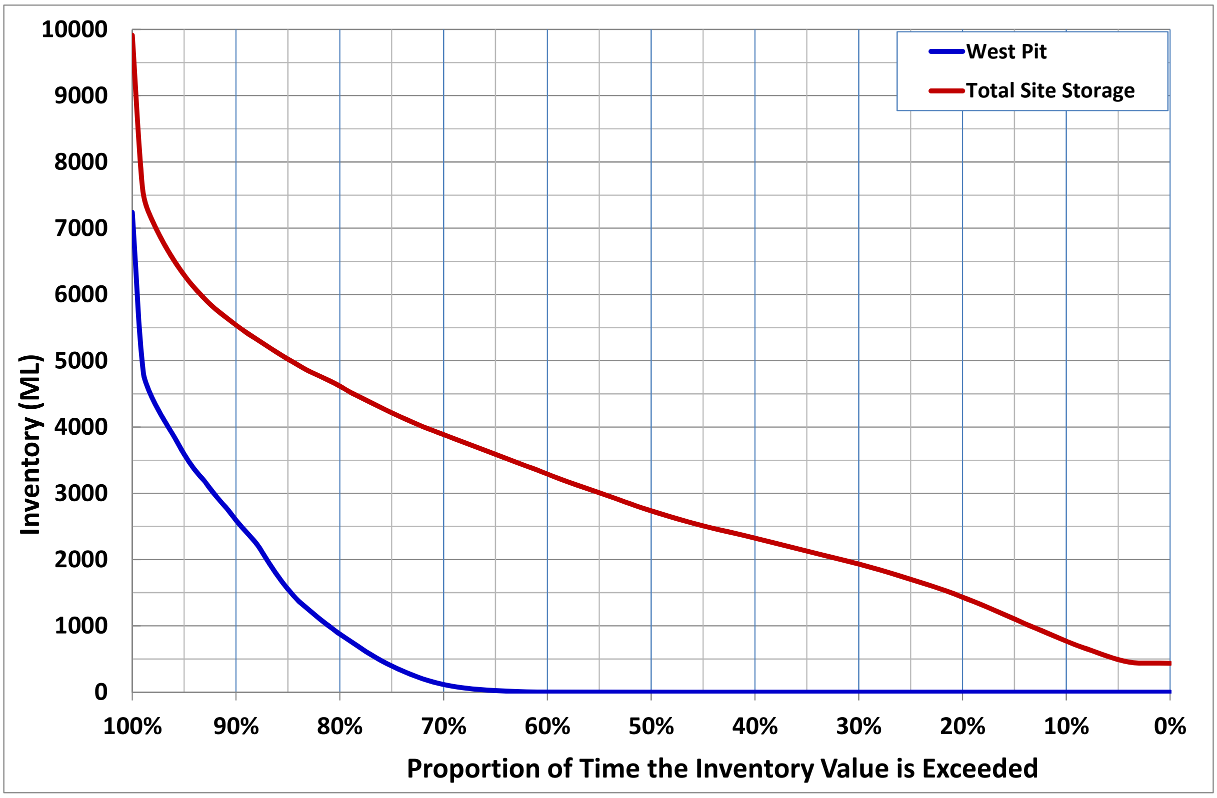


Figure 39: Residence Time in Pit

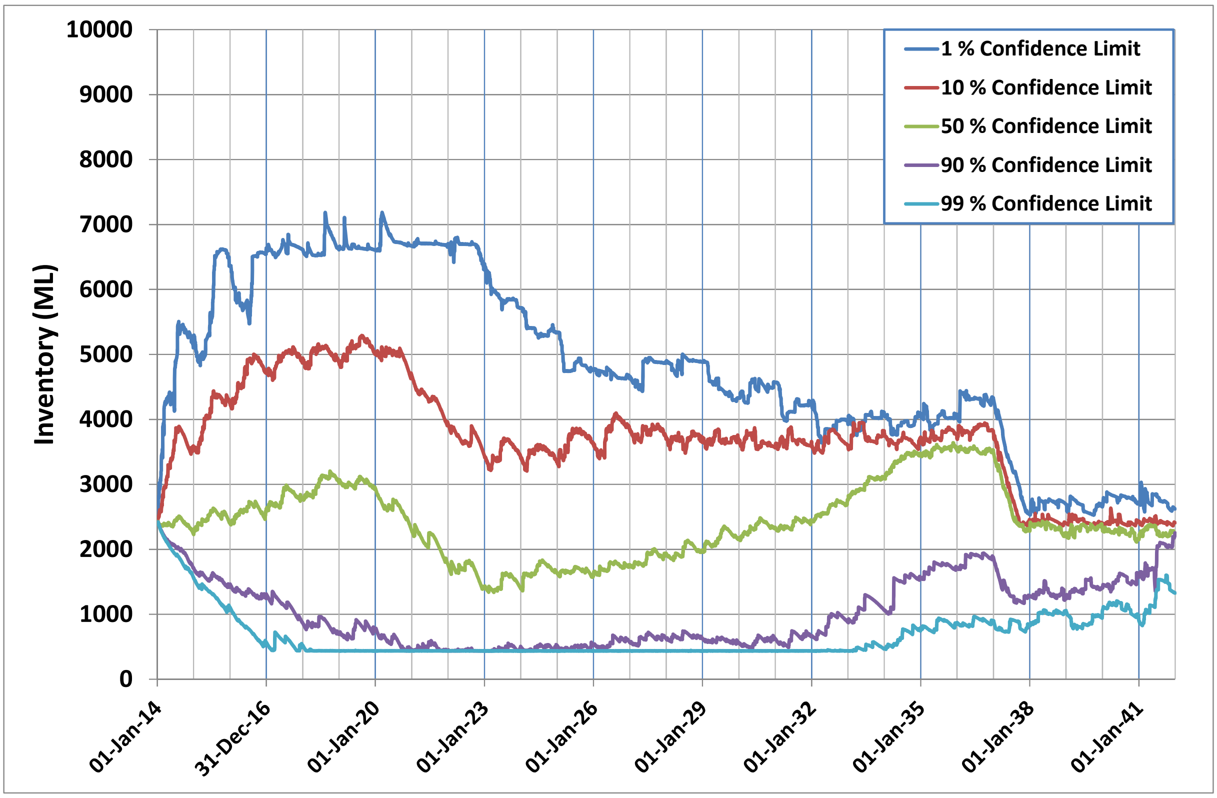


Figure 40: Forecasted Performance – Total Out of Pit Storage

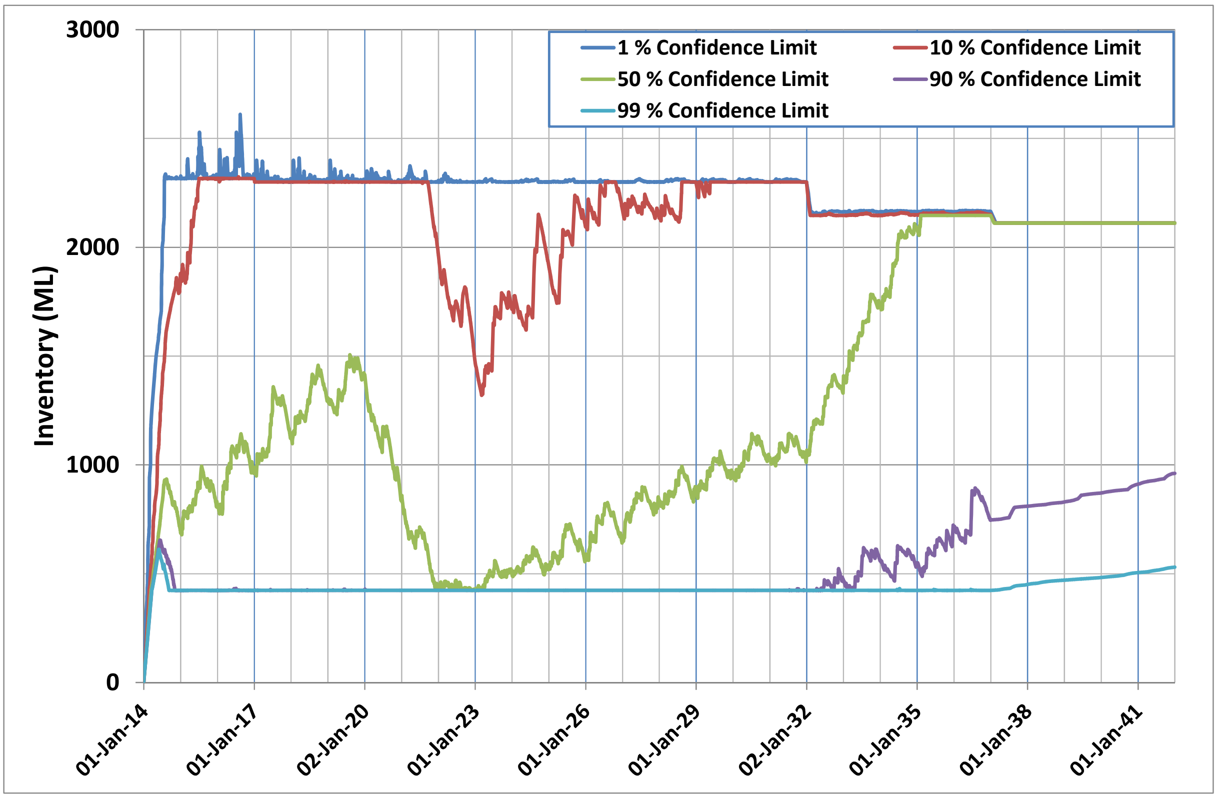


Figure 41: Forecasted Performance – North Pit Void

From 2036 the remaining North Pit sump space will become available to be filled with overburden. If the void space is required for overburden before 2036, additional out-of pit storage will need to be considered – refer to the 50th percentile plot on **Figure 41**. Modelling has assumed the North Pit sump remains open until 2036, and after that date the water level is maintained constant by dewatering to prevent spillage into the neighbouring Integra Coal Mine.

There is 10% likelihood that the West Pit will become unworkable by 2030 and out of pit storage may be required. Conversely, there is 90% confidence that additional out of pit storage will not be required. This relatively low risk of interruption to mining will be addressed by a form of adaptive management in order to minimise the potential for a large up front expenditure on a dam that is likely not to be required. The need for a dam will be addressed by regularly measuring site storage (monthly or quarterly) and reforecasting the risk of inundation using the OPSIM water balance model, based on the updated site inventory. This will require developing a good understanding of the stage-storage relationship for the major site storages and a consistent, reliable method of estimating site inventory. By way of example, the site inventory since the start of 2014 is plotted on **Figure 37**. The 2014 Inventory plot is tracking closer to the 90th percentile line, i.e. dry conditions, consequently the North Pit Sump is likely to be able to accept water from West Pit for several years and is unlikely to reach full capacity by 2018, even under 1st percentile (extremely wet) climatic conditions. Consequently, this risk of inundation of the West Pit at the time of writing is very low, with adequate time to adjust water management strategies and respond to extreme wet weather.

5.5.3 Imported Water Requirements

The model predicts that there is a better than even chance that water need to be imported at some time over the life of the project.

The tabulated values in **Table 19** were determined from the maximum external draw in any 12 month period for each of the 97 forecast cycles done by the OPSIM model. **Table 19** and **Figure 42** indicate that water is imported in at least 50% of the model cycles. The 50th percentile peak is 14 ML p.a., and the 1st percentile peak is 223 ML. Examination of **Table 19** indicates that, based on the currently held water share in the regulated and unregulated river (708 share units); the Mine can be confident that no additional licence allocation will be required over the life of the Project.

A sensitivity analysis on dust suppression rates by water carts was done to examine the effect on imported water requirements. The water cart usage was increased by 30%. Imported water is required in about 80% model cycles and the 1st percentile peak over any 12 month period increases to 1211 ML. The 50th percentile peak is 588 ML. There is about 60% certainty that the currently owned water allocations will be adequate.

Table 19: Maximum Imported Water Supply – Any 12 Month Period

Base Case: Water Carts 100%		Sensitivity Check: Increase Water Cart Rate by 30%	
Confidence Limit	**Volume (ML)**	**Confidence Limit**	**Volume (ML)**
-	-	18%	0
-	-	20%	52
-	-	30%	231
52%	0	40%	436
50%	14	50%	588
40%	116	60%	679
30%	167	70%	782
20%	175	80%	933
10%	202	90%	1105
1%	223	99%	1211

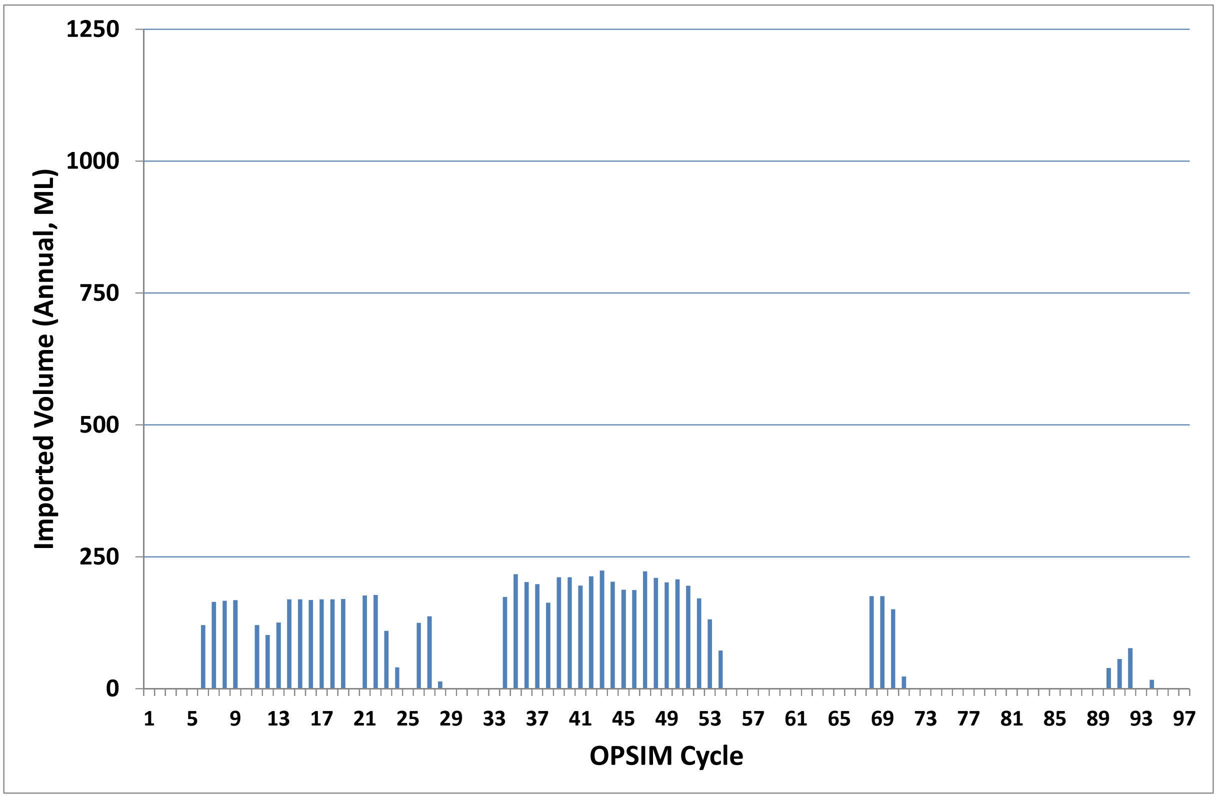


Figure 42: Maximum Imported Water - 97 OPSIM Cycles

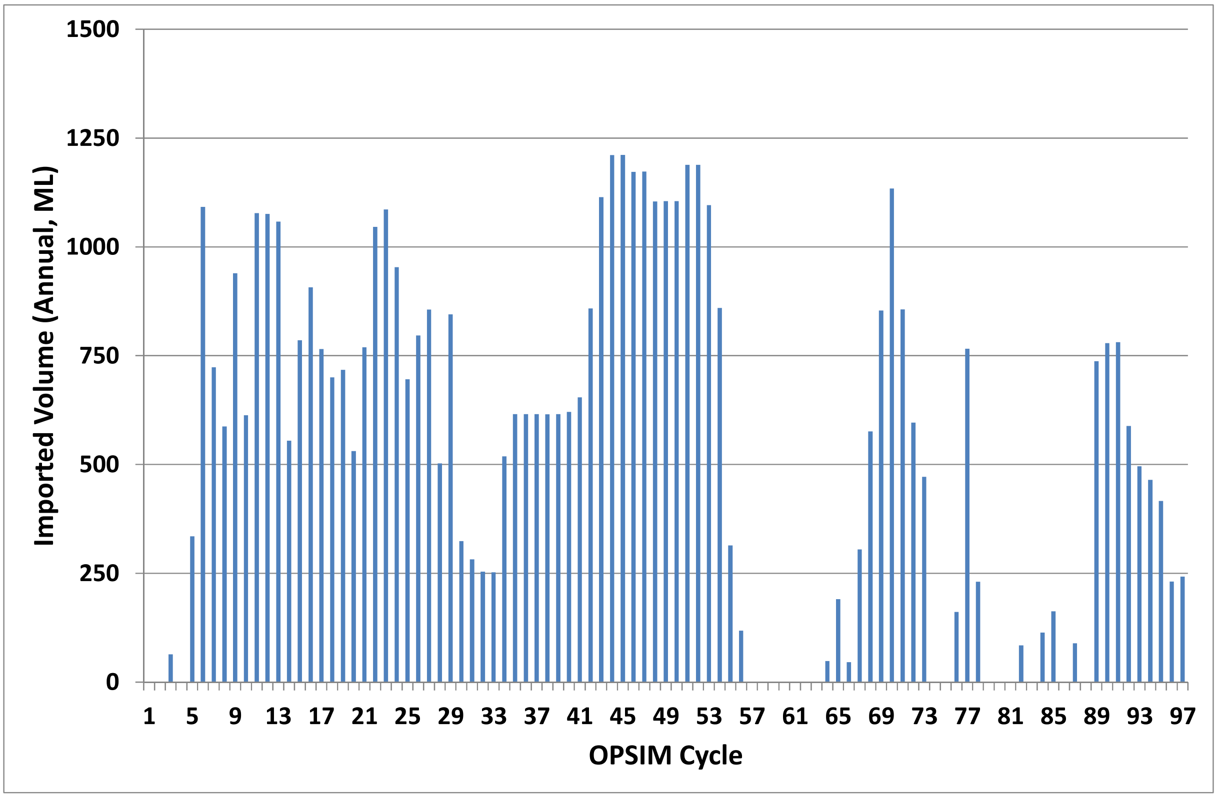


Figure 43: Maximum Imported Water – Sensitivity Run - 97 OPSIM Cycles

It is apparent that the site water balance is sensitive to additional water consumption. However, the Mine holds more than adequate water share for the forecasted external draw, and the allocations make the Mine reasonably insulated against errors on the forecast.

Should imported water be required, the Mine will access the regulated and unregulated river allocations it currently owns, and if required will purchase additional units on the open market, or approach other Water Access Licence holders for a term transfer. Alternatively, the Mine can negotiate water sharing agreements with neighbouring mines and investigate the use of dust suppressants to reduce water usage.

6.0 Impact Assessment

6.1 Potential Impacts

The potential impacts of the Project are as follows:

- Potential to degrade mine workability due to the build-up of water in the active mining areas.
- Potential to increase Hunter River flood levels and flood extent.
- Potential to require offsite make-up water supplies.
- Potential to reduce flows to Rixs Creek, Station Creek, and an Unnamed Tributary of the Hunter River; and
- Potential to impact on regional and local surface water quality.

An analysis of the potential impact on mining operations and potential requirements for off-site water supplies is summarised here and discussed in detail in Section 5. An assessment of the other potential impacts is given below. These impacts will directly relate to the safeguards and management measures presented in Section 7.0.

6.2 Operational Impacts

6.2.1 Flooding

The Hunter River lies about 1,100 m south of the southern lease boundary at the closest point, however this separated from the lease by cliffs formed from the basal sandstones along the northern edge of the river meander. The confluence of Rixs Creek with the Hunter River is about 2 km south by south west of the south west corner of the mining lease. The Rixs Creek valley floor i.e. the limit of alluvium is about 500 m wide and the creek is incised about 6 metres into the valley floor. The alluvium extends up the creek valley as far as Maison Dieu Road and Hunter River floods may back up as far as the lease boundary, about 4 metres above the top bank of the Hunter River.

The closest area of the Study Area footprint, the toe of an overburden embankment, is at least 17 m higher than the top bank of the Hunter River, and the lowest point on the pit shell is 20 metres above the top of bank.

Therefore the Mine is not on an active floodplain, nor is it exposed to flooding.

An existing irrigation pump station, Works Approval 20WA20103 with attached WAL's is located on the Hunter River – Refer **Figure 3**. The top river bank at this land lot is well above the 1% AEP flood level.

Although it is not required at this stage, a pump station and pipeline may be constructed from this location to supply the mine with raw water from the Hunter River. If the existing Works Approval proves inadequate, and a new pump station is required, the station will be located on the high bank of the Hunter River and the inlet will be designed in accordance with set standards and in consultation with NOW.

6.2.2 Loss of Catchment Flows

Table 20 shows the changes in the catchment area draining to Rixs Creek, an Un-named tributary and Station Creek over the life of the Mine. The original catchment water shed boundaries over the study area are shown on **Figure 4**.

The pre-mining catchment areas were determined based on the 1:25,000 topographic maps prior to the commencement of mining on both Rixs Creek and Integra Mine. The catchments areas were estimated for the whole of the catchment to the confluence with the downstream receiving waters – the Hunter River or Glennies Creek. Estimates of catchment loss are based on the whole of the catchment area.

Table 20: Catchment Change

Year	Rixs Creek (ha)	Station Creek (ha)	Unnamed Creek (ha)	Mining Area (ha)	Total (ha)	Catchment Loss Proportion
1990	2,562	2,413	1,402	0	6,378	0%
2014	1,986	2,305	1,321	766	6,378	12%
2017	2,036	2,305	1,319	717	6,378	11%
2020	2,106	2,427	1,351	494	6,378	7%
2023	2,097	2,435	1,311	534	6,378	8%
2026	2,155	2,435	1,272	517	6,378	8%

2042	2,428	2,447	1,260	243	6,378	4%

Rixs Creek

The Rixs Creek catchment is currently at the stage where the maximum expected catchment loss due to mining has occurred, around 22% of catchment area. The West Pit face continues to advance into Rixs Creek undisturbed catchments until 2022 but progressive rehabilitation at North Pit and South Pit offset and exceed the disturbance. The final catchment loss for Rixs Creek reduces to 5% or 134 ha, most of which is taken up by the final void.

There is at least one other licensed water user on Rixs Creek that could be impacted by the reduction in catchment flows.

Un-named Tributary of the Hunter River

This catchment has already been disturbed by activity in North Pit and 80 ha have been lost from the catchment. The western edge of the min pit runs along the boundary of the Un-named Tributary and Rixs Creek catchment. Consequently the level of disturbance ebbs and flows with disturbance and rehabilitation until 2026 and then increases to the maximum area of 142 ha in in 2042. The majority of the future catchment loss is due to catchment diversions due to the reconstructed landform rather than impacts from the mining pit. The proportion of catchment loss at the completion of open cut mining is 10%.

There is at least one other licensed water user on the Un-named Tributary that could be impacted by the reduction in catchment flows.

Station Creek

Integra Coal Mine is mostly located within the adjoining Station Creek catchment. The Station Creek catchment boundary meanders about of the northern boundary of the Mine. Current catchment loss due to disturbance by the Mine is 108 ha (4%), which is the maximum predicted. By 2020, rehabilitation activity at North Pit will divert sufficient area to Station Creek to increase the catchment to around 20 ha larger than the pre-mining catchment. At the completion of open cut mining, the Station Creek catchment will be increased by 33 ha or 1%.

Integra Coal Mine has been placed under care and maintenance. It is uncertain as to the future impacts from this mine on the Station Creek catchment. It is sufficient to say that at the completion of open cut mining there will be no future disturbance of the Station Creek catchment due to mining activity at Rixs Creek mine.

In summary, there will be a nett loss of 243 ha from the three catchments directly affected by this project. The loss of average annual runoff from reduced catchments is estimated at 75ML p.a. using average annual rainfall at Jerrys Plains of 645 mm and a volumetric runoff coefficient of 0.08 (See **Table 28** in **Appendix A**).

The reduction in catchment flows could potentially alter the geomorphic characteristics and ecological value of the Rixs Creek waterway and the Un-named Tributary. Advitech (2013) determined that the ecological integrity of the existing Rixs Creek channel was generally severely or extremely impaired due to existing land use practices. The habitat value was found to be low with little or no in-stream vegetation or rocks and snags for aquatic fauna. The existing stream morphology is directly related to the ecological integrity and is highly degraded. Measures to improve the ecological value and geomorphic integrity of the waterway and mitigate the impact of the loss of catchment flows are given in Section 7.

6.2.3 Water Quality

Land disturbance associated with mining has the potential to adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. In addition, runoff from active mining areas (including roads, coal stockpiles, etc.) may have increased concentrations of salts and other pollutants compared to natural runoff.

Rixs Creek and the Unnamed Tributary north of Rixs Creek are the streams most likely to be impacted by land disturbance or saline runoff. Using Rixs Creek as an analogue for impacts the following observations are made:

- EC, pH and TSS are consistent as each monitoring location since 1999 with no noticeable trend over that time period. Refer **Figure 15**, **Figure 16** and **Figure 17** in **Section3.7**.
- Reference to the Railway Underpass and Clean Water Dams water quality results indicate that runoff in two of the upper three catchments would meet potable water standards with minimal treatment.
- Average EC measured over the length of channel flowing past West Pit decreases moving downstream from around 1800 down to 1200EC. The 10th percentile EC results demonstrate

the same trend. Average pH is between 7.2 and 7.7; and TSS averages from about 60 to 140 NTU. In each case the 10th percentile results for pH and TSS show similar trends to the averages.

During the period mining has moved closer and then away from the remnant Rixs Creek Channel with no apparent effect on stream water quality.

To date there are no observable impacts on water quality due to the activity of the Mine, and provided existing management systems are maintained and measures recommended in Section 7 are adopted there is a low risk of impacts on water quality in the surrounding catchment due to ongoing mining operations.

6.2.4 Water Licencing

Surface Water Flows

The water management system for the Project has been designed to minimise the capture of clean runoff wherever possible. A clean water catchment diversion diverts water around the eastern perimeter of the CHPP to Clean Water Dam 6

The landform at West Pit drains away from the advancing highwall to the east across the New England Highway with no need for clean water diversion drains (referred to as West Rixs on **Figure 26**) There is minor disturbance in this catchment and sediment is settled out in SD 5 before the water flows off site.

The remaining dams are solely for the capture, containment and recirculation of mine affected water consistent with best management practice to prevent the contamination of a water source. These types of dams are “excluded works” and are exempt from the requirement for water supply works approvals and Water Access Licences. Therefore the water captured in these dams is not subject to licencing.

Table 21: Surface Water Allocations shows the estimated average volume of water captured within the water management system over the life of the project. Runoff volumes have been separated into clean water runoff draining or diverted off site, mine affected catchments draining to mine water containment dams, and disturbed area runoff draining to perimeter sediment dams before release off site.

The intercepted average annual runoff has been estimated using average annual rainfall at Jerrys Plains of 645 mm and a volumetric runoff coefficient of 0.08 (See **Table 28** in **Appendix A**). The total surface water entitlement for the unregulated river water source is 80,619 share units (normally ML p.a.). The Singleton Water Source, to which the Project applies, is a component of the unregulated river water source and is limited by an entitlement of 960 share units (ML p.a.), 350 of which are held by Rixs Creek Mine.

Table 21: Surface Water Allocations

Water Sharing Plan:		**The Hunter Unregulated and Alluvial Water Sources 2009**		
Water Source:		**Singleton Management Unit**		
Water Impacted	**Predicted Average Annual Volume (ML)**	**Percentage of Singleton Water Source Share Component (%)**	**Current Licences**	**Licences or Allocation Required**
Water captured in dams and diverted around the site back into the water source	60	6.3	WAL 19024 (150ML) WAL 19027 (300ML)	Yes
Water captured off mining areas and retained within mine water dams	221	23.	Exempt under Section 18(1) of the Water Management (General) Regulation 2011	Nil
Water off disturbed areas treated in sediment & erosion control dams and returned to the water source.	327	34	Exempt under Section 18(1) of the Water Management (General) Regulation 2011	Nil

Water Make Up Requirements

Water balance modelling (**Section 5.0**) indicates that external water supplies may be required during the life of the project to supplement on site water sources. **Table 19: Maximum Imported Water Supply** shows confidence limits for potential imported water volumes over the life of the project. The tabulated values are determined from the maximum annual external draw for each of the 97 forecast cycles done by the OPSIM model. For the Base Case, the 1% confidence value indicates that there is 1% chance that more than 1067 ML or more of water may need to be imported in any given 12 month period. The converse of this statement is that there is 99% confidence that less than 1067 ML may need to be imported.

The Mine holds WALs authorising abstraction of 450 ML annually from works in the upper Rixs catchment and 258 ML from the Regulated River (General Security). Examination of **Table 19** indicates that, holding this amount of allocation, the Mine can be confident that no additional licence allocation will be required over the life of the Project.

If more water is required, Rixs Creek Mine could either purchase additional units on the open market or approach other Water Access Licence holders for a term transfer, which may require an application to change the zone. Rixs Creek may have to obtain a Works Approval to pump from the Hunter River, and install a supply pipeline at least as far as West Pit. The Mine holds a current Works Approval 20WA201037, but the existing works are unlikely to be of sufficient capacity to convey water the distance required. The existing water use approvals attached to 20WA201037 are for irrigation and will need to be converted to mining purposes approvals.

Stream Diversion

A section of Stonequarry Gully will be consumed by open cut mining around 2035 and about 680 metres of the stream will need to be diverted. The proposed stream diversion will consist of two straight reaches joined by an acute angle bend, and merging bends to the existing stream at the upstream and downstream end of the diversion. The proposed stream diversion will require a Works Approval from DPI NSW Water. The route of the diversion is shown on **Figure 24**. The critical elements of the design are:

- A bed width of 6 metres.
- A bed slope of 0.61% at the downstream confluence and upstream to the upstream confluence. A bed slope of 0.8% leading in from the incoming channel at the upstream confluence.
- Side slopes of 1V:5H.
- Constructed in natural ground.
- The bed of the diversion will match the existing bed levels of Stonequarry Creek bed elevation.
- The estimated volume of material to be moved to create the diversion is 90,000 m^3.

The length of the diversion is about 700 metres, about 3% longer than the in situ stream, meaning the slope of the diversion channel is very similar to the natural stream. However the loss of meanders and some mature riparian vegetation means that velocities in the diversion may be generally higher, with associated erosion risks without an appropriate geomorphological design.

As identified in Section 3.6, the existing reach of Stonequarry Creek has a poorly developed riparian zone, generally only two trees deep either side. The River Styles® in the Hunter Catchment Report classified this stream reach as being in poor geomorphic condition. The stream reach is ephemeral and inspection of the reach indicated the stream bed provided no habitat for aquatic fauna and limited habitat for flora.

Licence Requirements

No additional Water Access Licences are required.

A Combined Works Approval and Water Use Approval may be required to replace 20WA201037 and 20UA201038, 20UA201039 and 20UA201040 if make up water is required from the Hunter River.
WAL 11919 will be attached to the new Works Approval.

A Controlled Activity Approval and Works Approval will be required to construct and operate a diversion to Stonequarry Creek in about 2033.

6.3 Cumulative Impacts

Loss of Catchment Flows

There are no other mines located in the Rixs Creek catchment, or in the catchment of the Un-named Tributary. Based on the basin geology, future open cut mining is unlikely, and will not be a source of future catchment disturbance.

At the completion of mining there is likely to be a small increase in area draining to the Station Creek catchment. Rixs Creek will have no adverse cumulative impact on this catchment.

7.0 Mitigation Management and Monitoring Measures

7.1 Water Quality

By implementing an effective system of mine water management, the Project will ensure no adverse impact on receiving waters. Key elements of the proposed water management system include:

- Diversion of runoff from undisturbed catchments away from disturbed areas, wherever possible, using surface drains.
- Treatment of runoff from overburden emplacements using sedimentation dams prior to discharge from the site; and
- Runoff from mining areas (including coal stockpiles) will be collected within mine water dams for recycling on site.

Details of the proposed mine water management system are provided in **Section 4.0**. Water balance modelling has been undertaken to demonstrate that the operation of the mine water management system will ensure that no uncontrolled releases occur from the mine water dams. Hence, the Project will not adversely affect surface water quality in downstream receiving waters. The methodology and results of the water balance modelling for the Project are provided in **Section 5.0**.

7.2 Minimisation of Off Site Water Demands

Should off site water be required, for instance if conditions in the early years of operation are drier than 1% percentile conditions, the Mine will access the regulated and unregulated river allocations that it owns in the Rixs Creek catchment, or purchase additional units on the open market, or approach other Water Access Licence holders for a term transfer. The Mine could also negotiate water sharing agreements with neighbouring mines to access sources of water from those sites where excess water is known to be a management problem, and avoid drawing on the external catchment altogether.

If the above actions prove unsuccessful and additional water is required, the Mine will establish a pump and pipeline on the Hunter River at the location shown on **Figure 3** to access the 258 unit general security allocation it currently owns. The current pump station operates under an existing Works Approval and Water Use Approvals for irrigation. With each works approval, detailed design will determine if the relevant pump station requires upgrading to supply water to the Mine at an acceptable rate and the Works Approval will be modified appropriately. The category of the Water Use Approvals will be transferred as required.

7.3 Surface Water Management and Monitoring

The proposed water management system, described in **Section 4.0** and **Section 5.0**, will ensure no adverse impact on receiving waters through the release of mine affected water. With respect to runoff from overburden emplacement areas, the following is of note:

- All sediment dams and water management systems will be designed in accordance with relevant standards (DECC 2008). The water quality of runoff will be regularly tested to ensure that it meets relevant standards prior to release from the site. If the quality of runoff from disturbed areas is not suitable for release, this water will be pumped into the mine water management system.
- The proposed sediment dams will be dewatered within five days after a runoff event to provide free storage capacity of at least the settling zone volume. Where TSS concentration in sediment dams after a runoff event is less than the selected water quality objective, sediment dams may be dewatered to receiving waters. Where TSS exceeds the water quality objective, water in basins must be either:
  - Flocculated to reduce TSS to less than the water quality objective.
  - Pumped to another water storage with available capacity; or
  - Pumped into the mine water management system.
- All surface water diversion drains, outlets, contour drains, catch drains and other waterways will be designed to convey peak runoff discharge rates for a 20 year ARI storm event (DECC, 2008). All drains are typically trapezoidal in section with 3H:1V channel batters and are designed to convey runoff at non erosive velocities of less than 1.5 m/s.

Runoff from mining areas (including coal stockpiles) will be collected within the various mine water dams, detailed in **Table 12**, for recycling on site; and water in excess of operational use will retained in these storages until it can be re-used.

Surface water monitoring will continue to be undertaken generally in accordance with the Rixs Creek Environmental Monitoring Plan (EMP). The EMP specifies that all major dams, both mine water and clean, are monitored on a monthly basis for storage volume, pH, EC, TDS, and TSS. The major ions: sodium, magnesium, potassium, calcium, chloride, sulphate and bicarbonates are sampled annually. The results will be reported in the Annual Environment Management Report. The EMP includes a Trigger Action and Response Plan which documents responses, actions and reporting requirements to abnormal monitoring results or undesirable trends in water quality.

The EMP will be progressively extended to include the additional water storages and regional catchments impacted by the Project. The timing of the additional monitoring would generally correspond to the conceptual mine plan as set out in **Figure 20 to Figure 24**. The existing and proposed monitoring locations are shown in **Figure 44**. A description of the monitoring sites is given in **Table 22**.

In addition to the surface water monitoring, data will be collected to update and validate the OPSIM water balance model. The updated model results will be reported as part of the Annual Environment Management Report to validate and/or update the assumptions made in this assessment. The model will be used to continually improve the water management system to maximise the use of mine affected water. Information that will be collected to update the OPSIM model and improve the water management system is as follows:

- Gauge plates will be installed in water storages to allow water levels to be regularly recorded.
- Pump rates and key storage levels will be systematically monitored, recorded and reviewed to validate the computerised water balance model predictions.
- A meteorological monitoring station will continue to be maintained at Rixs Creek recording hourly rainfall, evaporation and wind data at the site.
- Sediment management dams will be monitored to assess performance against the Blue Book guidelines and the POEO Act.
- Mine water dams and clean water dams will be monitored to understand water quality trends.

7.4 Stream Diversion

To achieve a velocity regime similar to the original creek reach, the stream form of the proposed diversion will need to be designed to account for the loss of meanders and mature vegetation that characterised the original channel. The design will provide geomorphological as well as hydraulic measures to minimise erosion and sedimentation and achieve a stable long term channel. The stream diversion design will include a management plan that includes monitoring and response measures to manage potential instability that may develop in the channel. It is technically feasible to produce a design for the stream diversion that will appropriately mitigate the abovementioned risks. At the appropriate time, an application for a Controlled Activity Approval and subsequent Works Approval will be developed in consultation with DPI Water NSW, supported by:

- Detailed design plans describing channel alignment, longitudinal sections and cross sections.
- A riparian corridor plan in accordance with “Guidelines for riparian corridors on waterfront land” DPI Water NSW 2012.

- A vegetation management plan in accordance with “Guidelines for vegetation management plans on waterfront land” DPI Water NSW 2012.
- A proposed monitoring regime to ensure ongoing health and stability of the stream.
- Contingency measures to address observed issues with establishment and performance of the stream diversion.

7.5 Catchment Loss

Rixs Creek holds WAL’s with sufficient water shares that can be surrendered to compensate for the permanent loss of catchment in Rixs Creek and the Un-named Tributary at the completion of mining.

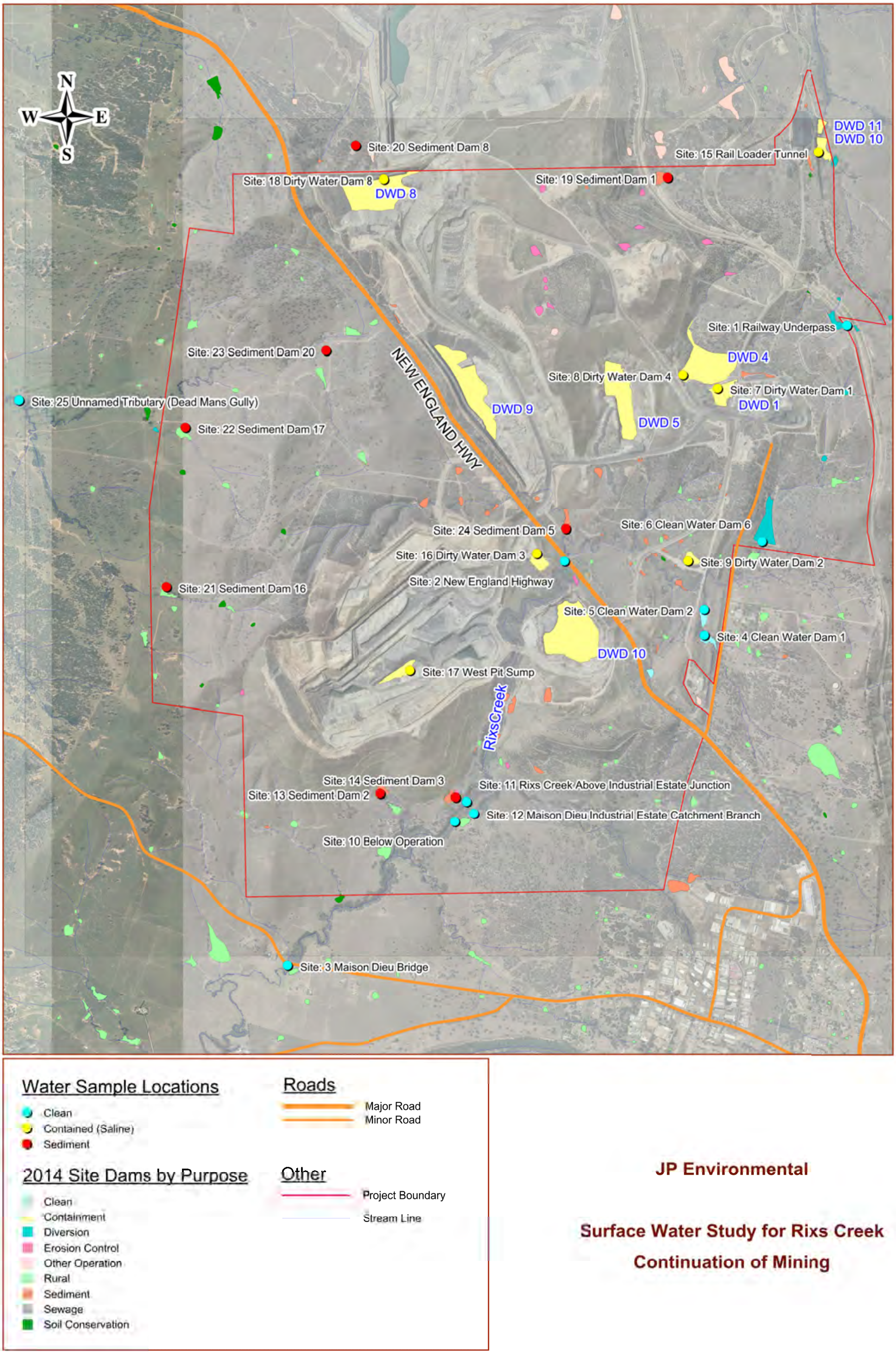
Table 22: Proposed Water Quality Monitoring Plan

Station ID	Type	Parameter	pH, EC, TSS, TDS[8]			Major Ions[9]
		Frequency	**Special[10]**	**Quarterly**	**Monthly**	**Annual**
1	Stream	Rail Underpass		1		1
2	Stream	New England Highway		1		1
3	Stream	Maison Dieu Bridge		1		1
4	Storage	Clean Water Dam 1 (CWD1)		1		
5	Storage	Clean Water Dam 2 (CWD2)		1		
6	Storage	Clean Water Dam 6 (CWD6)		1		
7	Storage	Dirty Water Dam 1			1	1
8	Storage	Dirty Water Dam 4 (CWD4-DWD4)	1		1	1
9	Storage	Dirty Water Dam 2		1		
10	Stream	Site 10 – Below Operation		1		1
11	Stream	Above Industrial Estate Junction	1			1
12	Stream	Maison Dieu Industrial Estate Catchment Branch	1			1
13	Storage	Sediment Dam 2 - Pit 3 West	1			
14	Storage	Sediment Dam 3 - Pit 3 East	1			
15	Storage	Rail Loader Dam	1			
16	Storage	Dirty Water Dam 3		1		
17	Storage	West Pit In-Pit Storage			1	1
18	Storage	North Pit Sump (DWD8)		1		1
19	Storage	Sediment Dam 1 - Pit 1 North East	1			
20	Storage	Sediment Dam 8 - Pit 1 North	1			
21	Storage	Sediment Dam 16 - Pit 3 West	1			
22	Storage	Sediment Dam 17 - Pit 3 West	1			
23	Storage	Sediment Dam 20 - Pit 3 North	1			
24	Storage	Sediment Dam 5 - Pit 1 South	1			
25	Stream	Unnamed tributary (Dead Man's Gully)			1	1

8 EC – Electrical Conductivity; TSS – Total Suspended Solids; TDS – Total Dissolved Solids.

9 Comprehensive analysis includes major ions AL, As, B, Ba, Be, Ca, CaCO3, Total Cl, Cd, Co, CO3, Cu, F, Fe (soluble), HCO3, Hg, K, Li, Mg, Mn, Na, NH3, Ni, NO2, NO3, OH, P, Pb, Rb, Sb, Se, Si, SO4 (or S), Sr, Zn

10 Special sampling occurs at least annually; or when sufficient runoff is generated to either create appreciable flow in a stream or to cause a spillway to operate. Normal analytes: EC, TSS, Turbidity and TDS. At least one sample annually from at least one active sediment dam on Pit1 and Pit 3 should also be subjected to a comprehensive analysis – see Note 5 above.



JP Environmental

Surface Water Study for Rixs Creek Continuation of Mining

Figure 37: Water Quality Monitoring Plan - Proposed

8.0 Conclusion

The Project is a planned continuation of the existing Rixs Creek Mine to continue the existing mining operation at the Mine and to mine up to 4.5Mtpa ROM coal per year over 28 years. The Mine is located approximately 5km north-west of Singleton in the Hunter Coalfields. A water management system has been developed for the Project that includes:

- A mine water management system (water that has come in contact with coal) to collect and use water that may contain high TDS (salt) concentrations.
- A tailings water management system to dewater tailings to a dry cake at the CHPP eliminating the need for a permanent tailings disposal facility.
- A sediment and erosion management system to ensure runoff from disturbed areas is separated from clean area runoff and collected in sediment dams for treatment and release.
- A clean water management system to divert water undisturbed by mining around the Rixs Creek disturbance footprint; and
- A contaminated water management system for water that has come in contact with chemicals of various types used in the mining operations.

Water Balance Modelling

Water balance modelling was undertaken to assess the performance of the proposed water management system. The results of the water balance modelling are as follows:

Overall Performance of the System:

- Under the proposed water management system, runoff from the Rixs Creek Mine catchments and dewatered groundwater can supply all water requirements up to 50th percentile dry conditions at Rixs Creek South over the life of the Project. For drier than 50th percentile conditions, the peak annual demand for imported water gradually increases to a maximum of 224 Ml for the 99th percentile climate regime (extreme dry). The majority of the offsite demand occurs in the first half of the project life. The overall site water demand generally rises as ROM production rises. Even in the most extreme climate cycle, imported water is required for only 10 out of the 28 years of the project life, with an average use of 36 ML p.a..
- The water management system can contain saline water on site without off site discharges for most foreseeable climatic conditions. This comes with a risk of impaired mining production for conditions wetter than 10th percentile climate regime.

Performance of West Pit:

- Under 50th percentile conditions i.e. “average” conditions, no water will accumulate in West Pit over the life of the Project. Under the 20th percentile conditions, or wet conditions, up to 1,300

ML of water may accumulate in West Pit before coal in the pit is exhausted, but for almost 70% of the time West Pit is dry under this climatic regime.

- Pit workability would normally be adversely impacted by more than 500 ML of water held in West Pit due to out of pit storages being full and unable to accept water. This scenario is not likely to occur until late in the third quarter of the mine life under the 10th percentile climatic conditions, and if an adaptive approach is taken to water management there should be adequate lead time to provide more out of pit storage or to initiate operations under the HRSTS, however the prevailing risk regime is slanted towards water shortage.

Sensitivity Analysis

- The results of the water cart usage sensitivity analysis are indicative of the climate variability of the region. When the water balance is in equilibrium, there could potentially be both shortfalls in demand, requiring offsite make-up water, or a build-up of water that impacts on operational workability depending upon whether wet or dry conditions are experienced over the Project life. Given that current storage inventory will reduce over the early part of the Project life, there is merit be merit in investigating minimising water use via strategies such as dust suppressants, and also considering the impact of installing an out of pit storage with an HRSTS discharge point to balance out the extremes in the water balance. Minimising, or eliminating, the requirement for offsite supplies is the preferred approach from both an operational and environmental perspective.
- Water cart usage has a significant impact on the water balance. The sensitivity analysis found that with a 30% increase in water cart dust suppression, there is a significant increase in imported water volumes over the life of the project with more frequent peak demands as high as 1,221 Ml per year, a fivefold increase over base case conditions.

Water Quality

The Project will not impact on off site water quality due to spillages from the mine water dams:

- The North Pit Void, CHPP Dams, Old North Pit, Dirty Water Dam 3 or the Old Underground Workings do not spill over the Project life. The 1% confidence plot indicates Dirty Water Dam 2 may spill up to 0.6 ML over the life of the project
- Current water management and planning systems are effectively preventing spills

Water Licencing Requirements

Water Access Licences currently owned by Rixs Creek Mine are likely to satisfy any water supply shortfall under this scenario, even with increased water cart usage rates used in the sensitivity analysis. If more water is required, Rixs Creek Mine could either purchase additional units on the open market or approach other Water Access Licence holders for a term transfer, which may require an application to change the zone. Rixs Creek may have to obtain a Works Approval to pump from the Hunter River, and install a supply pipeline at least as far as West Pit. The Mine holds a current Works Approval but the existing works are unlikely to be of sufficient capacity to convey water the distance required.

A section of Stonequarry Gully will be consumed by open cut mining around 2035 and about 680 metres of the stream will need to be diverted. The proposed stream diversion will require a Works Approval. A design that addresses appropriate hydraulic and geomorphological aspects of the proposed diverted stream will adequately mitigate any potential erosion, deposition and stream stability risks.

Catchment Loss

The Project will reduce the Rixs Creek catchment by a maximum of 22%, and is currently at this maximum, reducing to 5% at the completion of mining. The Project will add about 1% to the original size of Station Creek; however the major impact on this catchment will remain to be Integra Coal. An Un-named Tributary of the Hunter River to the west of West Pit will lose 10% of its original size at the completion of mining. Overall, 243 ha will be permanently lost to the final void and underground portal.

The Project will have an insignificant impact on the Hunter River flows. Under mining conditions, the Project will reduce the catchment draining to the Hunter River at Singleton by less than 0.1% and the catchment loss at completion of mining equates to 0.015%

Rixs Creek holds WAL's that can be surrendered to compensate for the permanent loss of catchment in Rixs Creek and the Un-named Tributary at the completion of mining.

Flooding

The Rixs Creek West Pit disturbance footprint is located outside of the 100 year ARI flood extent of both the Hunter River and Rixs Creek.

9.0 References

Advitech, 2013	Rixs Creek - Ecological Impact Assessment, 11 December 2013
ANZECC/ARMCANZ, 2000	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality
Boughton & Chiew, 2003	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality
DEC, 2006	Using ANZECC Guidelines and Water Quality Objectives in NSW Department of Environment and Conservation NSW, June 2006
DEC, 2006	Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries, Published by the Department of Environment and Climate Change in association with the Sydney Metropolitan Water Board June 2008
DIPNR, 2003	Water Sharing Plan (WSP) for the Hunter Regulated River Water Sources NSW Government Legislation Current Version
DIPNR, 2005	Management of stream/aquifer systems in coal mining developments. Department of Infrastructure, Planning and Natural Resources Hunter Region Version 1 April 2005.
DNR, 2006	River Styles® in the Hunter Catchment. Prepared by the Department of Natural Resources In conjunction with the Hunter-Central Rivers Catchment Management Authority, 25 September 2006 Version 1.3.
DPIWE, 2003	Waterways & Wetlands – Works Manual. Tasmania Department of Primary Industries, Water and Environment.
Hoyle J, et al, 2008	Spatial variability in the timing, nature and extent of channel response to typical human disturbance along the Upper Hunter River, New South Wales, Australia. Earth Surface Processes and Landforms. Volume 33, Issue 6, pages 868–889, May 2008
JP Environmental, 2014	Rixs Creek Colliery: Stream Impact Assessment for a Proposed Discharge Point under the Hunter River Salinity Trading Scheme. 15th May 2014
Landcom, 2004	Management of stream/aquifer systems in coal mining developments. Department of Infrastructure, Planning and Natural Resources Hunter Region Version 1 April 2005.
Landcom, 2006	Managing Urban Stormwater Soils and Construction – Volume 1 Revised 4th Edition July 2006.
Jeffrey SJ et al, 2001	Using Spatial Interpolation to Construct a Comprehensive Archive of Australian Climate Data, Environmental Modelling & Software, Vol 16/4, pp 309-300, 2001.
Morton, 1983	Morton, F.I., 1983, ‘Operational estimates of areal evapotranspiration and

	their significance to the science and practice of hydrology', Journal of Hydrology, Vol. 66, No. 1-4, pp. 1-76.
Mulder, 1997	Queensland Lake and Aerial Evaporation, Volume 1, Report prepared by J.C. Mulder, Department of Natural Resources, Resources Sciences Centre, Water Assessment Group, September 1997.
Patterson Britton & Partners, 1992	Geomorphology of the Lower Hunter River. Prepared by Patterson Britton & Partners for the Hunter Catchment Management Trust, 1992.
Pilgrim, 1998	Pilgrim, DH, (ed)., Australian Rainfall & Runoff - A Guide to Flood Estimation, Institution of Engineers, Australia, Barton, ACT, 1998
RPS Aquaterra, 2014	Rix's Creek Continuation Of Mining Project Groundwater Impact Assessment 30 September 2014
Steward AL et al, 2012	"When the river runs dry: human and ecological values of dry riverbeds."; The Ecological Society of America; www.frontiersinecology.org; 29 March 2012.
Strahler, 1957	"Quantitative analysis of watershed geomorphology", Transactions of the American Geophysical Union 8 (6): 913–920.