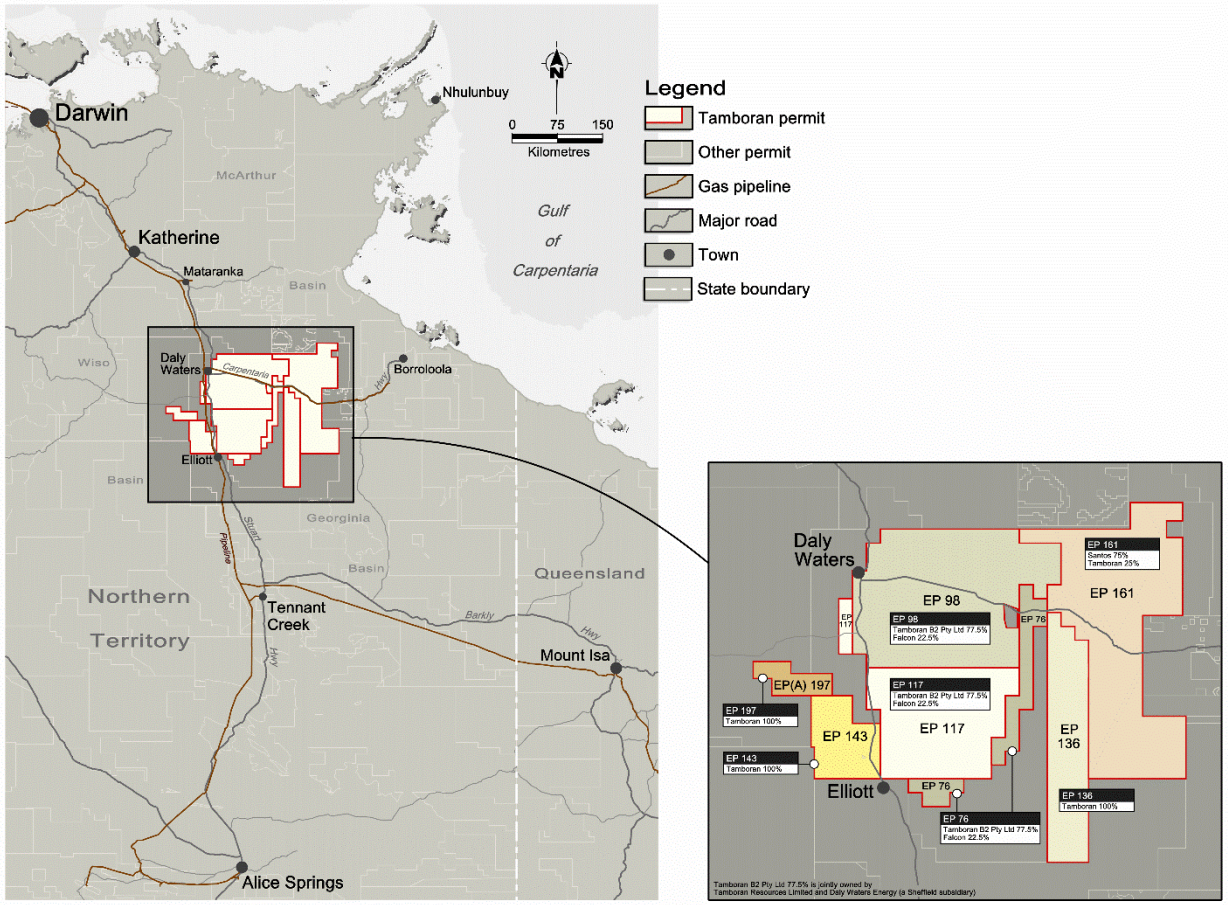
Appendix N.1.2 18 230630 WEL Licence submission and presentation

Water Extraction License Overview

30 June 2023 –

Carpentaria Highway, Northern Territory Australia

Tamboran's Exploration Activities – Increase in Water Extraction Licence



- Tamboran's petroleum exploration targeting the Shale Formations of the Beetaloo Sub-Basin- specifically the Velkerri shale
- As E&A activities progress, larger volumes of water will be required to support longer horizontal wells with bigger hydraulic facture stimulations
- Longer wells and bigger fracks reduce the number of wells we need to drill- reducing surface footprint and increasing water efficiency.
- Tamboran currently has a Water Extraction Licence of 175ML/year and is planning to increase this to 450 ML/year from both the Gum Ridge Formation (GRF) and the Anthony Lagoon Formation (together they for the ***Cambrian Limestone Aquifers*** (***CLA***))

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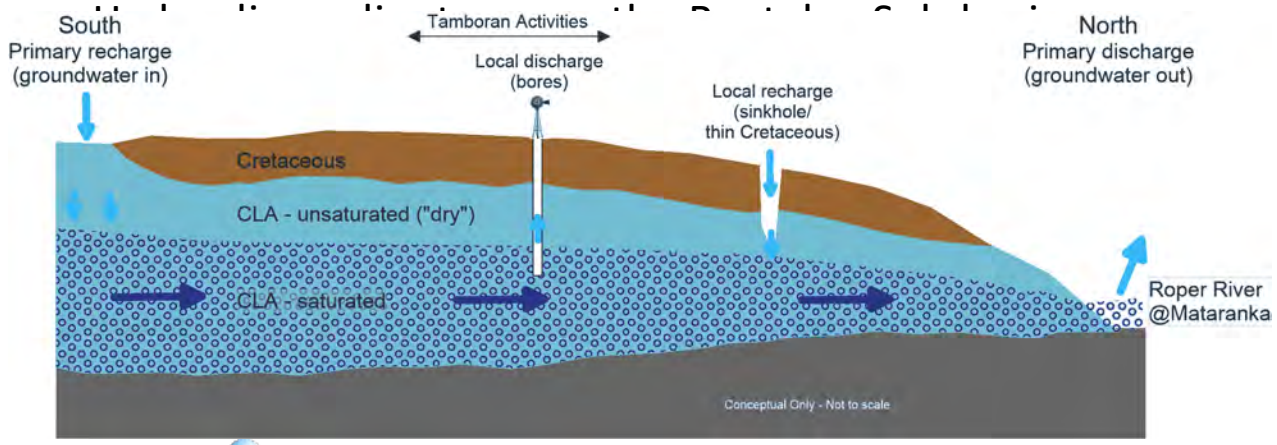
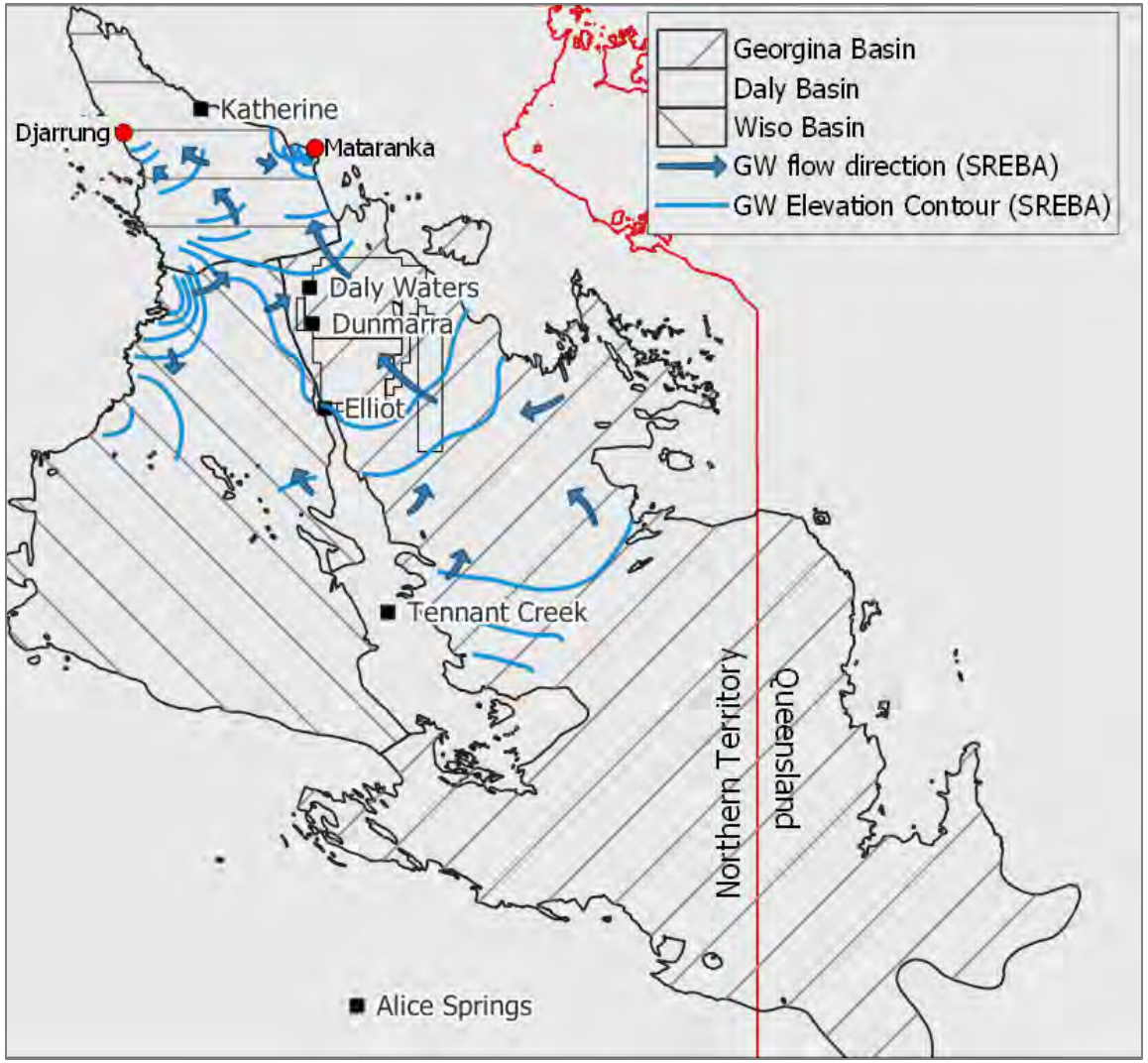
Cambrian Limestone Aquifer Characteristics

- CLA extends from Queensland to north of Katherine
- Groundwater flow is generally from south to north
- Estimated 1,810,000 – 3,690,000 GL volume of groundwater stored in the CLA*
- Estimated current usage of ~42 GL/year*
- Recharge through sinkholes and where the Cretaceous cover is thin may locally change the flow direction*
- Majority of discharge is to the Roper River at Mataranka and the Flora River near Djarrung* ~150km from Tamboran's closest proposed location





*CloudGMS, 2020

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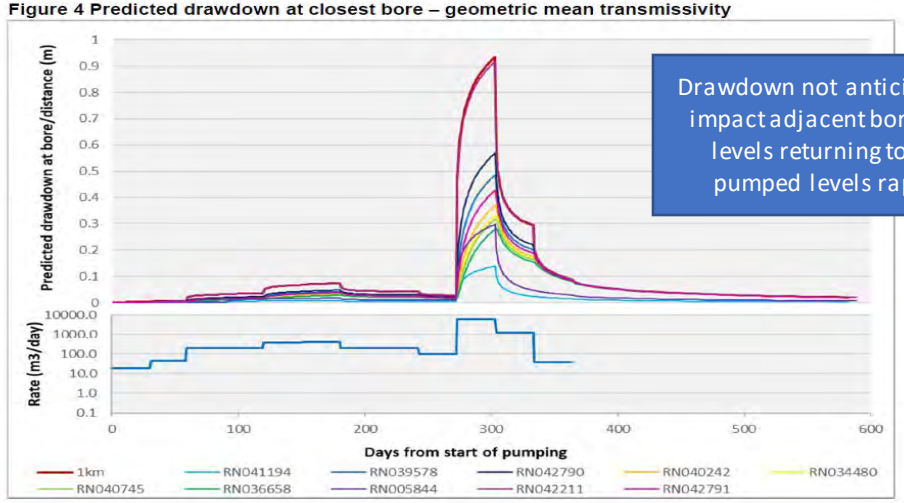
Water Extraction Licence – Impact Assessment

- WEL increase from 175ML/year to 450ML year from Gum Ridge
- Tamboran's proposed Water Extraction Level is small:
  - 0.004% of current usage from the CLA
  - 0.00005% of estimated volume of water in the CLA
- Conservative modelling based on aquifer pump tests confirms extracting will not have material impacts on water levels, with levels returning to pre-pumped levels
- Observed monitoring data indicates water levels will rapidly recover post pumping returning to pre-pumped levels

Figure 4 Predicted drawdown at closest bore – geometric mean transmissivity



Drawdown not anticipated to impact adjacent bores with levels returning to pre-pumped levels rapidly

Monitoring of groundwater levels post pumping (~30ML) do not show any material level declines

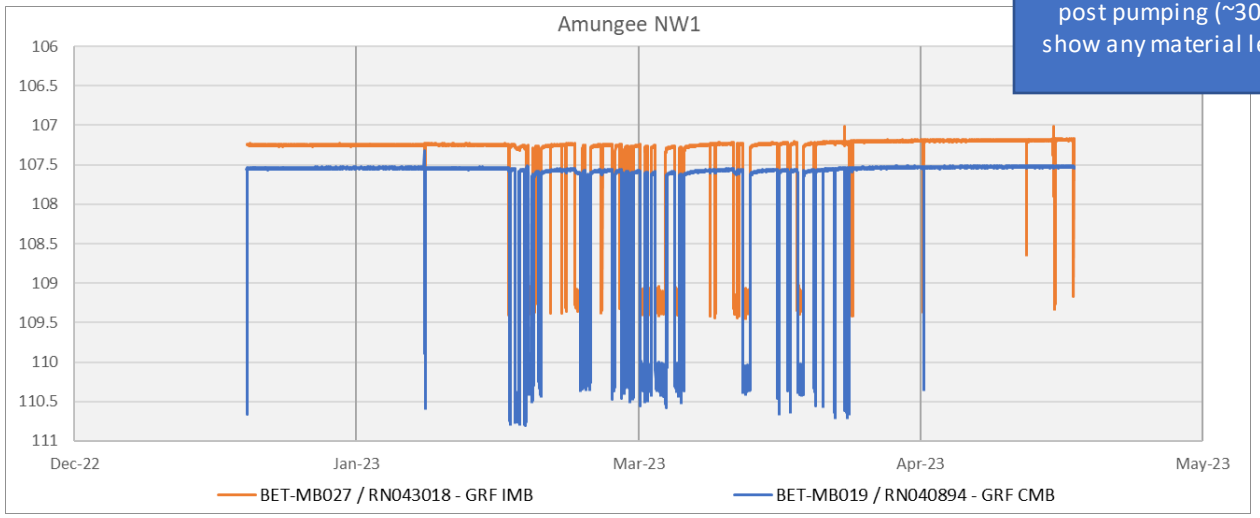
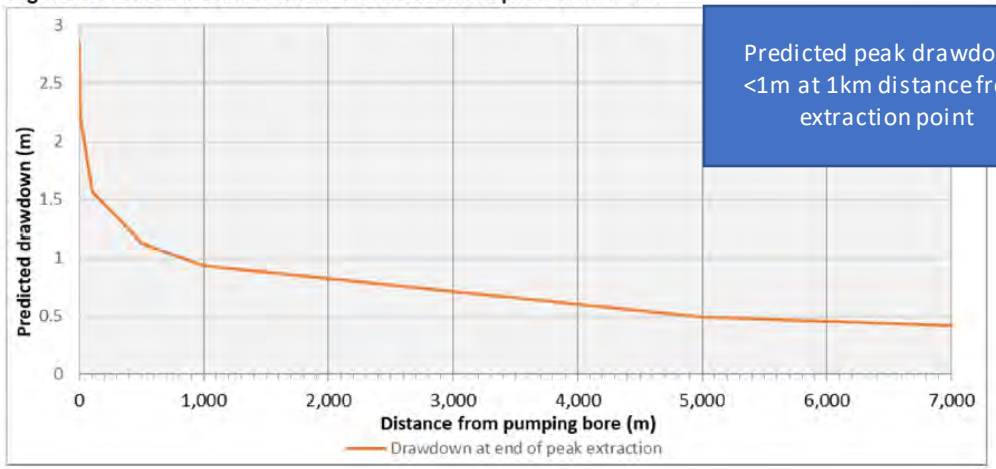


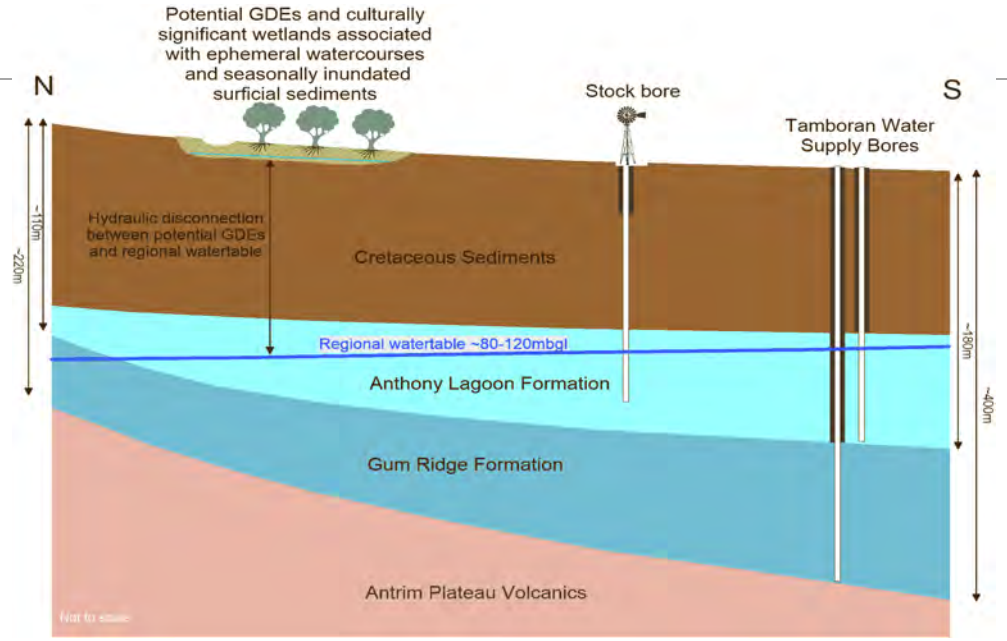
Figure 5 Predicted drawdown vs distance at end peak drawdown

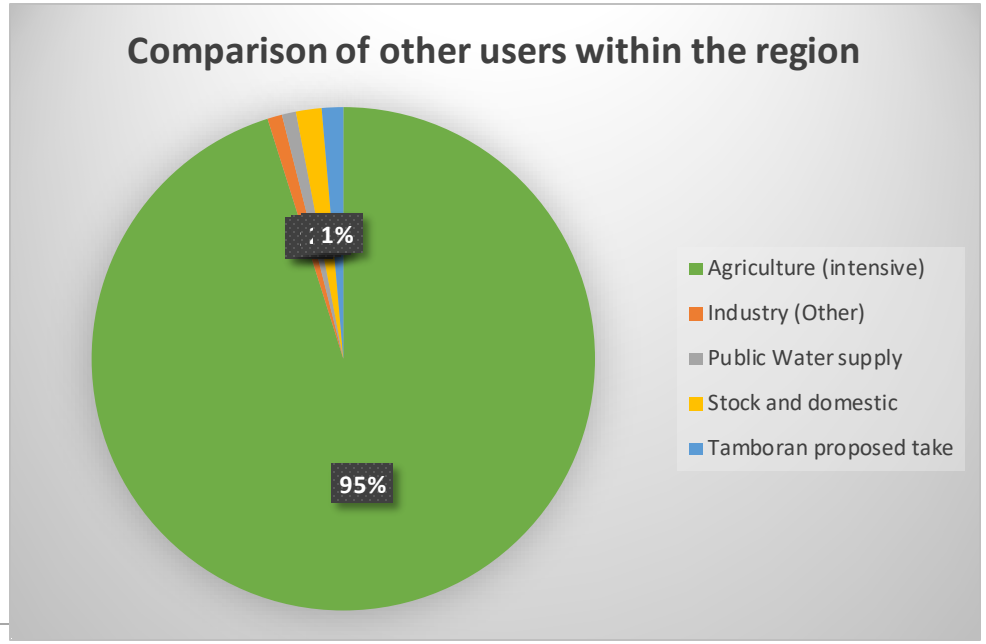


Predicted peak drawdown <1m at 1km distance from extraction point

Culturally sensitive areas- no impacts

- Water extraction to support Tamboran's exploration activities <u>will not impact features such as water holes, creeks or Springs</u>
- Surface waterbodies, such as Newcastle creek and Lake Woods, are supported by shallow groundwater in seasonally saturated surficial sediments- not the CLA
- The surficial sediments are hydraulically disconnected from the CLA, as illustrated in the adjacent picture
- Springs, such as Mataranka, are located ~150km North of Tamboran's closest activities.
- Independent assessment of future industry take by the GBA confirms full scale extraction will not materially impact springs (low likelihood) with an additional; sustainable yields of up to 40,000ML/year available^
- Tamboran's proposed Water Extraction Licence volume ~90 times smaller than available yield and less than 1% of current take in the region#





^https://bioregionalassessments.gov.au/42-potential-impacts-water
#https://depws.nt.gov.au/__data/assets/pdf_file/0005/438008/Background-Brief-Tindall-Limestone-Aquifer-Mataranka-to-Daly-Waters.pdf

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References

- Cook, P.G. and Eamus, D. (2018). The Potential for Groundwater use by Vegetation in the Australian Arid Zone. Department of Environment and Natural Resources, Environment, Northern Territory Government, Darwin.
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- SREBA (2023) Regional Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. DEPWS Technical Report 41/2022. Department of Environment, Parks and Water Security, Northern Territory Government. Berrimah, Northern Territory.
- CloudGMS (2020) Upgrade of the Coupled Model of the Cambrian Limestone Aquifer and the Roper River Systems. Version 1.0 October 2020. WRD Technical Report 57/2020. Prepared for the Department of Environment, Pars and Water Security.

Tamboran Resources Ltd

Water Extraction Licence Application – Gum Ridge Formation

Groundwater Impact Assessment

3 May 2023

Tamboran B2 Pty Ltd (Tamboran) is the current operator of petroleum exploration permits (EP) 76, 98 and 117 in the Beetaloo Sub-basin, Northern Territory (NT).

Tamboran's exploration and appraisal activities will involve the drilling, stimulation and production testing of shale gas exploration wells targeting organic shales of the Velkerri Formation of the Roper Group, at depths generally in excess of 2,000 m below ground level (mbgl), at well sites across the EPs. Multiple wells may be drilled at each wellsite. The locations of the exploration sites are shown on Figure 1.

A water supply is required for the exploration activities, including civil construction, drilling and hydraulic stimulation. Tamboran currently holds NT groundwater extraction licence GRF10285, which authorises up to 175 ML/year from the Gum Ridge Formation. To support its planned exploration activities, Tamboran is seeking to increase the annual volumetric authorisation of GRF10285 to 450 ML/year.

1. Conceptual hydrogeological model

The hydrostratigraphy of the Beetaloo Sub-basin is summarised in Table 1. A schematic diagram of the conceptual hydrogeological model is provided as Figure 2.

The target aquifer of this license application is the Gum Ridge Formation (GRF), which is a karstic, clean limestone that can be in excess of 200 m thick. The GRF is overlain by the Anthony Lagoon Formation(ALF), which is characterised by interbedded limestone and siltstone, and is often unsaturated in the northern parts of Tamboran's EPs. Together the GRF and ALF comprise the Cambrian Limestone Aquifer (CLA) of the Georgina Basin. The Georgina Basin extends south to between Tennant Creek and Alice Springs, southeast into Queensland and merges into the Daly Basin to the north, which extends to near the town of Adelaide River. The CLA does not outcrop within Tamboran's EPs and is covered by siltstone and claystone rich Cretaceous-aged Carpentaria Basin deposits. These have been observed to be greater than 140 m thick, and are generally unsaturated in the north, but may be partially saturated in the south/central of the EPs.

Tickell and Bruwer (2017) presented a potentiometric surface for the Cambrian Limestone Aquifer, which shows a general southeast to northwest groundwater flow direction across the Beetaloo Sub-basin (shown on Figure 1 and Figure 3). This is consistent with a recharge source where the CLA outcrops to the southeast of the Beetaloo Sub-basin, and discharges primarily to the Roper River (CloudGMS, 2020). Tickell and Bruwer (2017) describe a component of "mountain front" recharge along the Stuart Highway in the vicinity of Elliot, resulting in a westerly oriented groundwater flow direction in that area of the formation.

Figure 3 presents a depth to water map generated from water level measurements sourced from NR Maps. The map shows that water levels across the EPs range from approximately 80 to 120 mbgl in the vicinities of the planned exploration sites. The depth to water is reaches up to ~160 mbgl to the east of the Amungee sites and may be within 20 mbgl in the far north of EP98 in the around the headwaters of the Hodgson and Cox Rivers. The SREBA (DEPAWS, 2022) indicates that the source of the water for these springs (Hot Springs valley) may be as deep as 1,100m as the springs flow at a temperature of up to 65°. An ephemeral perched aquifer has been observed in the vicinity of the Amungee wellsites. This aquifer is understood to be associated seasonal

inundation of surficial sediments associated with drainage lines. Monitoring bores drilled into this aquifer indicate that it is less than 10 m thick, with seasonal water fluctuations of over 5m. SREBA (DEPAWS, 2022) identifies that the lack of perennially flowing waterways are due to the lack of groundwater discharge areas due to the depth of the regional water table.

Three hundred and four (304) registered bores were identified within Tamboran's EPs, which includes current and historical bores and investigation and monitoring bores. The primary use of the groundwater in the region is for stock watering. Table 2 provides a summary of the closest current bore to each of the exploration sites. This does not include bores that Origin installed for monitoring or water supply purposes.

Table 1 Beetaloo Sub-basin hydrostratigraphic summary (after CloudGMS, 2015)

Geological Province	Period / Age	Formation		Hydrostratigraphic designation
CARPENTARIA BASIN	**CRETACEOUS**	Undifferentiated		Local Aquifer
GEORGINA BASIN	**CAMBRIAN**	Cambrian Limestone Aquifer (CLA)	Anthony Lagoon Formation	REGIONAL AQUIFER
			Gum Ridge Formation	REGIONAL AQUIFER
		Antrim Plateau Volcanics		REGIONAL AQUITARD Local Aquifer
BETALOO SUB-BASIN (ROPER GROUP)	**NOT KNOWN**	Cox Formation		REGIONAL AQUITARD Local Aquifer
		Bukalara Sandstone		Local Aquifer
	MESO-PROTEROZOIC	Kyalla Formation		REGIONAL AQUITARD
		Moroak Sandstone		Local Aquifer
		Velkerri Formation		REGIONAL AQUITARD
		Bessie Ck Sandstone		Local Aquifer

Table 2 Summary of the closest current registered bores to the planned exploration sites

Exploration Site	Nearest RN	Distance (m)	Completion depth (m)	Water level (m)	Yield class
Amungee NW1	RN005844	4,250	124	111.3	>1.0 - 2.0 L/s
Amungee NW3	RN042211	1,060	209.3	97.4	>10 L/s
Amungee NW4	RN042791	6,410	145	110	>2.0 - 5.0 L/s
Velkerri 76 S2	RN036658	11,260	111	75	>5.0 - 10.0 L/s
Kyalla 117 N2	RN041194	7,310	132	102	>10 L/s
Shenandoah Nth 1	RN039578	5,150	125	99.2	>2.0 - 5.0 L/s
Shenandoah Nth 2	RN042790	3,780	131	97	>2.0 - 5.0 L/s
Shendandoah S A	RN040242	8,000	100	84	0 L/s
Shendandoah S B	RN034480	9,220	114	95.2	>2.0 - 5.0 L/s
Shendandoah S C	RN040745	9,770	125	103	>1.0 - 2.0 L/s

Figure 1 Locations of exploration sites

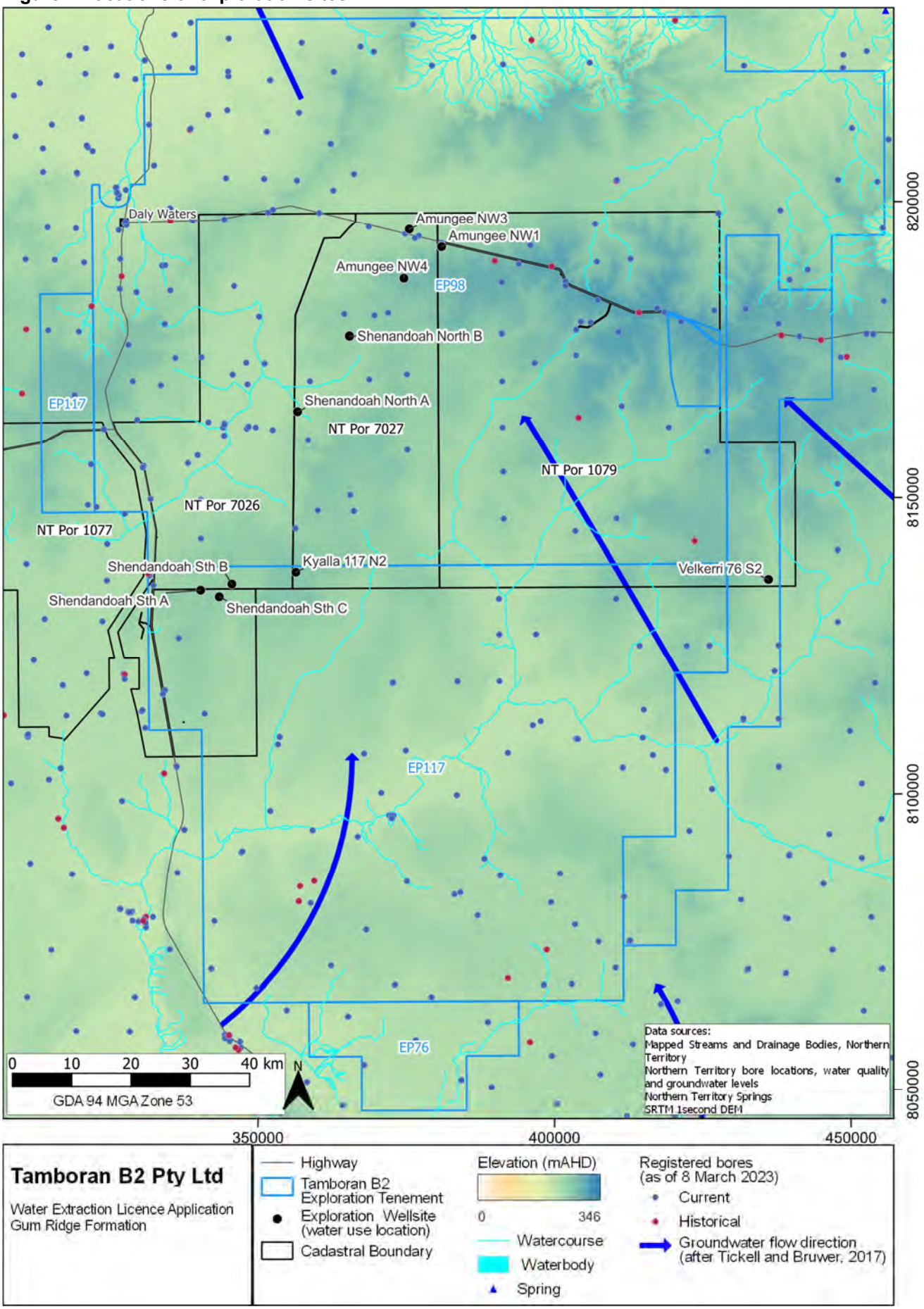


Figure 2 Conceptual hydrogeological model

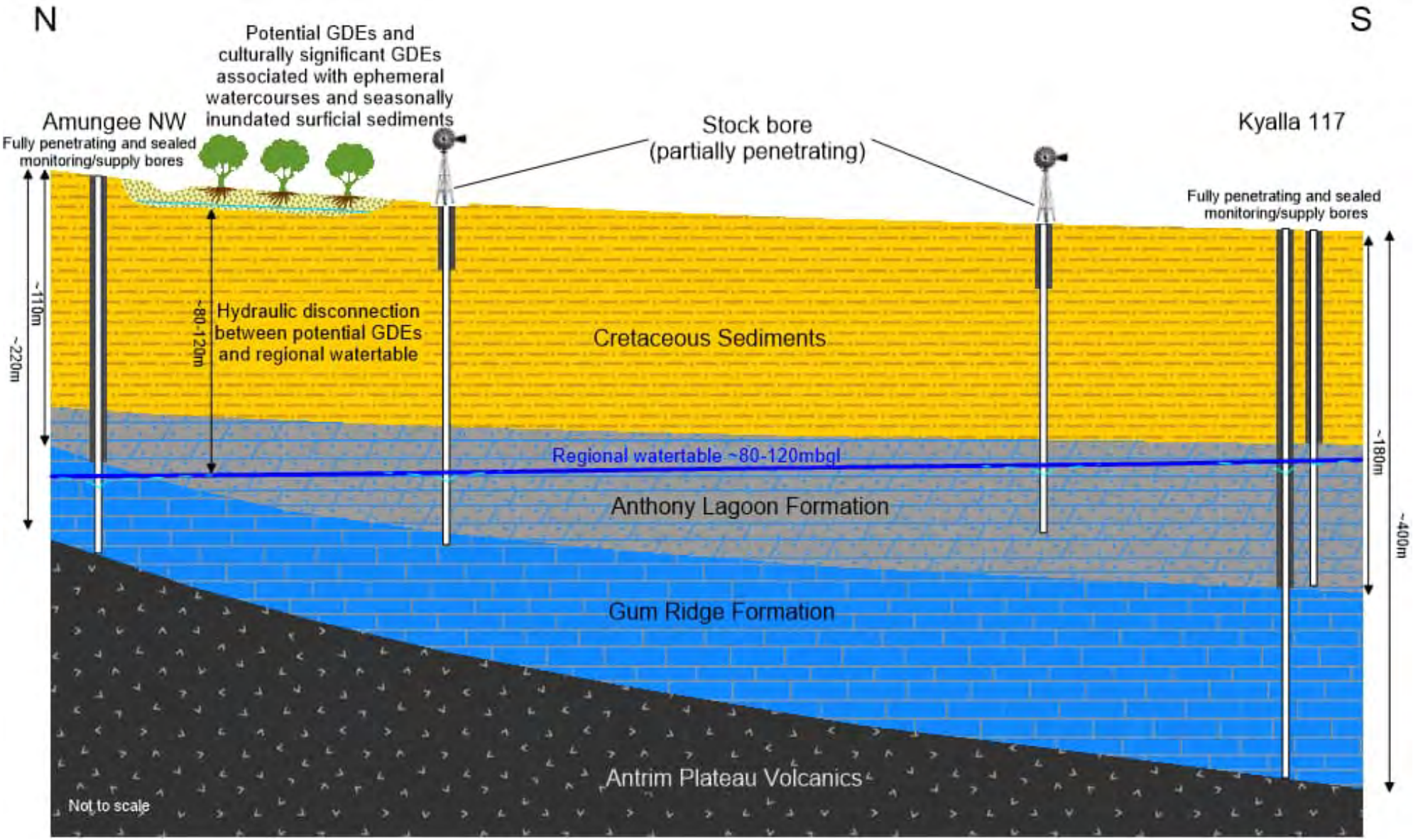
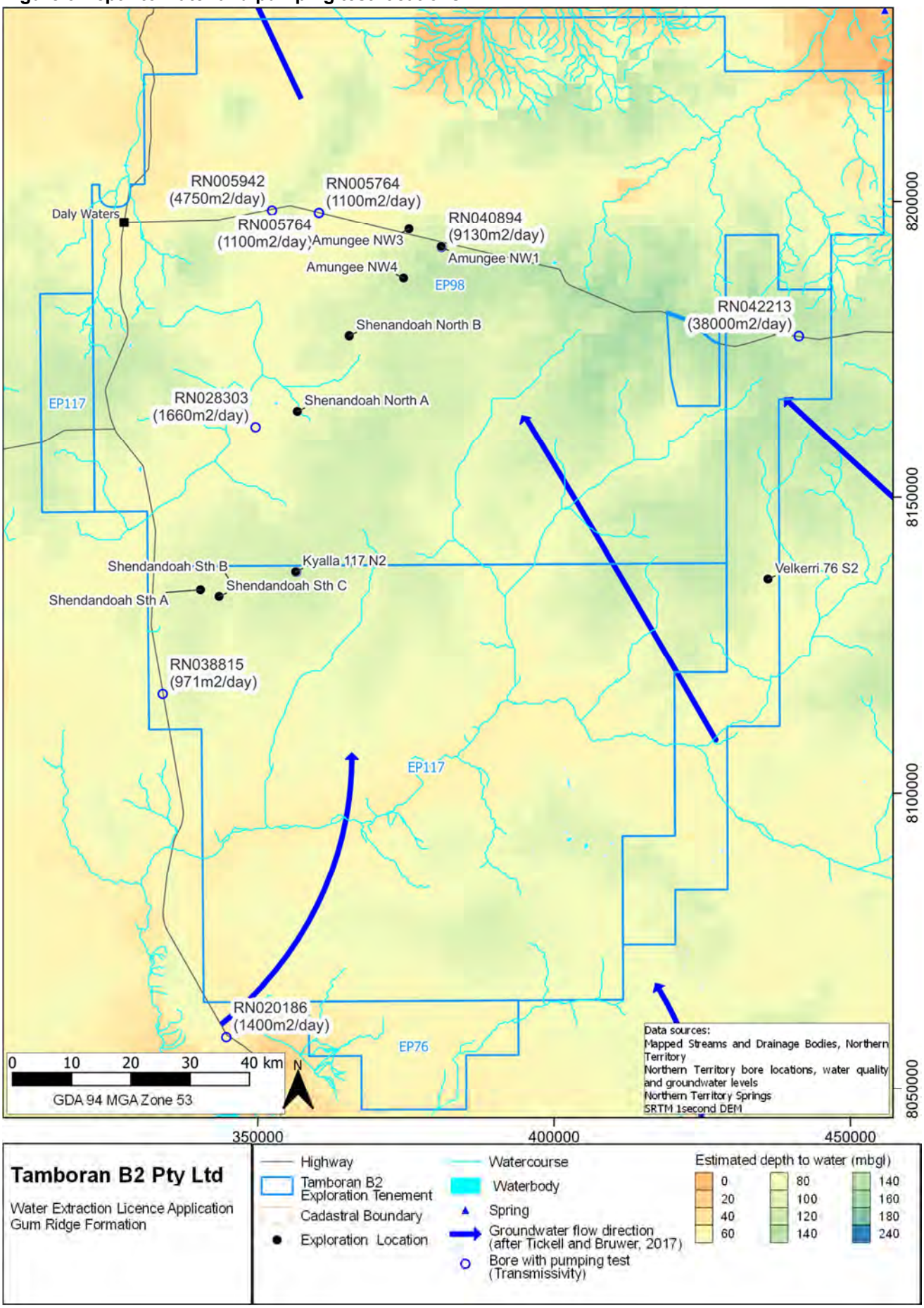


Figure 3 Depth to water and pumping test locations



2. Potential impacts associated with groundwater extraction

The extraction of groundwater has the potential to impact other users through drawdown of water levels without proper management.

The depth to the regional watertable in the CLA aquifer ranges from 80 to 120 mbgl in the vicinities of the planned exploration sites, which indicates it is unlikely the aquifer is supporting any terrestrial or aquatic groundwater dependent ecosystems (GDEs). These groundwater depths are consistent with the findings of the Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin (SREBA) (DEPAWS, 2022). Aquatic GDEs require very shallow groundwater levels to support inflow into surface water features. Terrestrial GDEs, where groundwater supports vegetation, can be present where the watertable is deeper. Cook and Eamus (2018) found evidence of significant groundwater use in arid zone areas with a watertable depth of 8-12 m and some evidence of groundwater use in vegetation at depths of 15 – 20 m. Groundwater is considered unlikely to support terrestrial GDEs at watertable depths exceeding 20 mbgl. The SREBA (DEPAWS, 2022) identifies small, disparate areas of low to moderate confidence seasonal GDEs across the region, however these are likely to be associated with shallow, perched systems.

DEPAWS (2022) identifies stygofauna "*are most abundant in aquifers with a relatively shallow depth to groundwater, well-developed superficial karst features, and transmissive and interconnected saturated habitat space. Annual recharge into the aquifer may be important to stygal ecosystems to maintain suitable groundwater quality and to provide primary trophic level inputs to subterranean food webs."* These conditions are generally only met when where the aquifers are close to surface, in the vicinity of Mataranka and Katherine, several hundred kilometres north of the proposed extraction sites.

A seasonal perched aquifer has been observed in the vicinity of the Amungee wellsites which terrestrial GDEs may utilise. This perched aquifer is associated with surficial sediments only and is hydraulically disconnected from the regional water table by an unsaturated zone that is more than 100 m thick.

NR Maps identifies no springs within the Tamboran EPs. The closest mapped springs are where the shallow watertable is mapped along the Cox River to the northwest of EP98.

Any drawdown associated with Tamboran's extraction will only affect the water level in the regional watertable and will not affect the availability of water to GDEs.

Potential impacts to groundwater bores has been assessed using an analytical model based on the Theis (1935) solution with superposition of time based on the method described by Birsoy and Summers (1982) to account for variable pumping rates. The model was run for a 400-day period at a daily timestep, with the last 35 days run at a zero rate to observe the predicted rate of recovery. The extraction rates were based on Tamboran's maximum expected monthly water extraction, as shown in Table 3, which is for simultaneous activities for up to five wells but proportionally reduced for three wells, the maximum number of wells that are expected to be installed at one site. Hydraulic parameters for the model were sourced from pumping tests performed by Origin on existing monitoring/supply bores and analysed by RDM Hydro, from data identified in Tickell and Bruwer (2017), and from the analysis of pumping test data included in registered bore reports from NR Maps. The hydraulic parameters are summarised in Table 4 and the locations of the bores with test results are shown on Figure 3. The transmissivities of the Origin tests are significantly greater than those from Tickell and Bruwer (2017) and some of the other registered bores. This is likely due to the requirement for monitoring bores drilled and constructed in accordance with the *Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin* (DENR, 2018) and used for water supply to fully penetrate the aquifer, whereas stock and other bores may only penetrate a small portion of the upper part of the aquifer. The geometric mean is therefore biased towards the lower values from the partially penetrating bores and will result in over-prediction of drawdowns. The single available storage coefficient was used throughout.

Timeseries water level predictions were made at the distances of the closest bores identified in Table 2 and at a distance of 1 km from the pumping bore. Model predictions are presented as Figure 4 and Figure 5 presents

the predicted drawdown with increasing distance from the pumping bore at the end of the peak water usage (304 days), when the magnitude of predicted drawdown was at its greatest. The predictions indicate:

- Drawdown is not predicted to exceed 1 m at 1 km.
- The much greater site-specific transmissivities from fully penetrating bores, as would be installed by Tamboran, would result in the prediction of significantly less drawdown and negligible potential for drawdown at neighbouring bores.
- Based on the distance-drawdown curve presented as Figure 5, drawdown in excess of 1 m may extend up to 900 m from the pumping bore.
- Water level drawdown will recover rapidly following the reduction of peak water usage.
- A smaller number of wells will reduce the water demand and therefore the predicted drawdown.

Table 3 Estimated maximum monthly water extraction (ML)

Month	Jan	Feb	Mar	Apr	**May**	**Jun**	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	Total
Estimated Volume	1	2	10	10	20	20	10	10	5	300	60	2	450
Main Activity	Civil construction, camps, general (CCG)						Drilling			Stimulation		CCG	-

Table 4 Gum Ridge Formation hydraulic parameters

Tested bore	Transmissivity (m^2/day)	Storage Coefficient (-)	Source
RN041132	17,900		Origin/RDM
RN040894	9,130		Origin/RDM
RN038815	971	$2.76x10^{-4}$	NTG (Tickell and Bruwer, 2017)
RN005164	1,100		NTG (Tickell and Bruwer, 2017)
RN028303	1,660		NTG (Tickell and Bruwer, 2017)
RN020186	1,400		NTG (Tickell and Bruwer, 2017)
RN042213	38,000		RDM (data from NTG)
RN005764	1,100		NTG/RDM
RN006329	2,262		RDM (data from NTG)
RN005942	4,750		RDM (data from NTG)
Geometric Mean	**3,358**		

Figure 4 Predicted drawdown at closest bore – geometric mean transmissivity

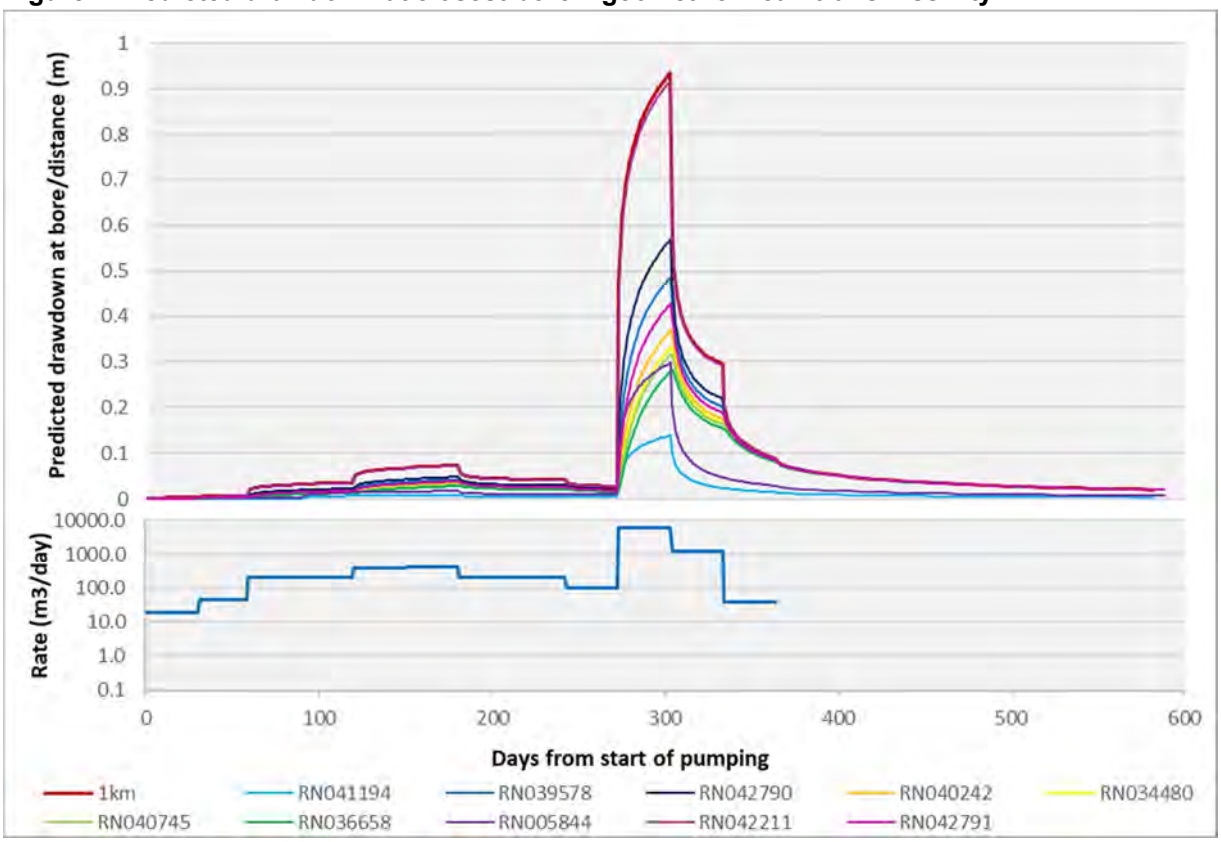
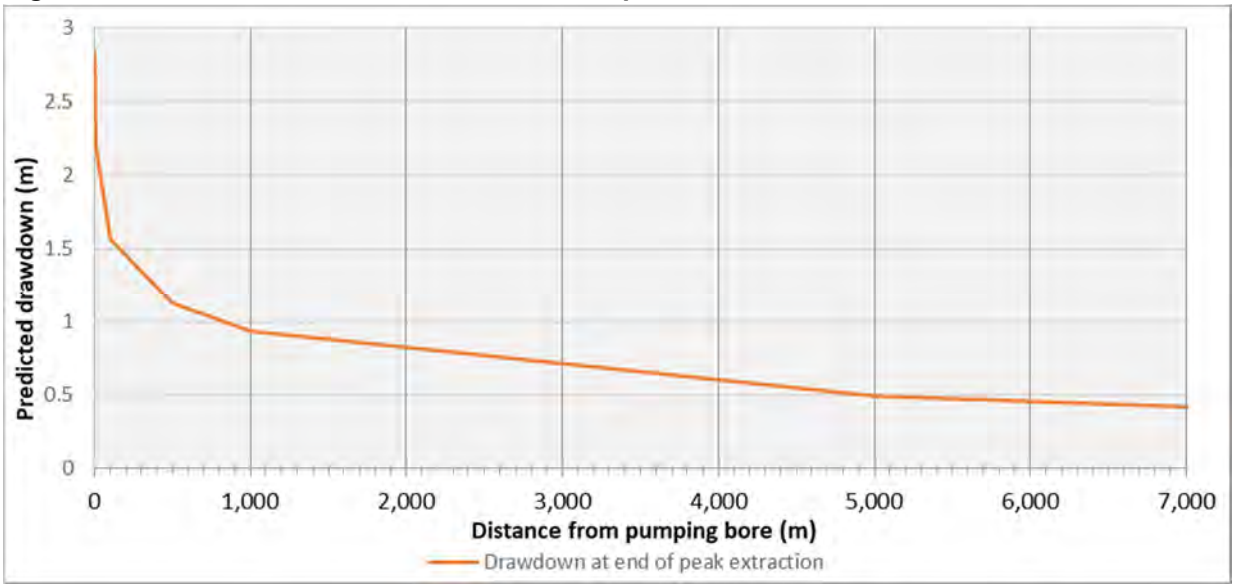


Figure 5 Predicted drawdown vs distance at end peak drawdown



3. Conclusions and recommendations

Tamboran requires up to 450 ML/year of groundwater from the Gum Ridge Formation to support its exploration activities across ten wellsites on EP76, EP98 and EP117 in the Beetaloo Sub-Basin.

The watertable depth ranges from 80 to 120 mbgl in the vicinities of the planned exploration sites. Groundwater is considered unlikely to support terrestrial GDEs at watertable depths exceeding 20 mbgl (Cook and Eamus, 2018). Any drawdown associated with Tamboran's extraction will not affect the availability of water to GDEs.

Site-specific testing of bores constructed to be fully penetrating the Gum Ridge Formation and in accordance with the *Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin* (DENR, 2018) reveal transmissivities significantly greater than those values obtained from other tests in the region. Based on the geometric mean transmissivity of the available test data, drawdown is not predicted to exceed 1 m beyond 900 m from a production bore. The closest identified water supply bore is 1.1 km distant from a Tamboran wellsite (Amungee NW3).

It is recommended that:

- Tamboran undertake pumping tests following the installation of any bores that will be used for water supply purposes to provide a site-specific aquifer transmissivity.
- The modelling should be re-run to assess whether predicted drawdown will exceed 1 m at the nearest registered water supply bore not belonging to Tamboran.
- A baseline assessment should be performed on any current water supply bores not belonging to Tamboran within 5 km of Tamboran's licensed bores. Where bore equipment permits, this should include:
    - Measurement of standing water level,
    - Measurement of pumping water level,
    - Collection of a water quality sample,
    - Notes and photographs of bore headworks and pumping equipment, and
    - Provision of the data to the bore owner.

4. References

Birsoy, Y.K. and Summers, W.K. (1980) Determination of aquifer parameters from step tests and intermittent pumping, Ground Water, vol. 18, no. 2, pp. 137-146.

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Appendix N.1.2 19 230705 AAPA certificate Application subject land

Shape File - See Attachment

From: Emily Beresford-Cane [redacted]
Sent: Wednesday, July 5, 2023 10:31 AM
To: [redacted]
Cc: [redacted]
Subject: AAPA info

Hi Jeremy

Please find attached requested AAPA information.

Please let Stewart know that the scope of the Certificate has been included in the description in the shape file.

Don't hesitate to let Matt know if you have any questions.

Regards

Emily

AAPA Authority Certificate Request- Subject Land 2 (Shenandoah South Pilot Area)

EP98, 117, 76 – Beetaloo Joint Venture (Tamboran / Falcon)

Version:	**1.0**
Submitted:	June 12 2023
Presented by:	Tamboran

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1 Introduction

Tamboran B2 Pty Ltd (ABN 42 105 431 525) (*Tamboran*) holds a 77.5% ownership interest in Exploration Permits (EP) 76, 98 and 117 (the Permits) under the Beetaloo Joint Venture (JV) with Falcon Oil and Gas (the Beetaloo JV). Tamboran B2's *Northern Territory Government work program commitments* require the completion of ongoing exploration and appraisal (E&A) activities as a condition of approval. Since 2015, the Beetaloo JV has drilled eight (8) wells in the Beetaloo Sub-basin (Beetaloo). These include Kalala S 1, Beetaloo W 1, Amungee NW 1, Amungee NW 1H, Kyalla 117 N2 1, Kyalla 117 N2 1H, Velkerri 76 S2 1 and the recently drilled Amungee NW 2H (December 2022).

As a part of its Calendar Year 2023-2025 work program (***work program)***, Tamboran B2 is proposing to undertake a range of additional exploration and appraisal activities across its tenure to test the technical and commercial viability of the Velkerri Formation. This includes the civil construction of a series of new exploration locations and the drilling, completion, stimulation and testing of a series of exploration wells on EP 98 and EP 117 within the "Subject Land 2".

In 2019, Origin Energy B2 Pty Ltd (which was acquired by Tamboran B1 Pty Ltd in 2022 and renamed to Tamboran B2 Pty Ltd) submitted a clearance request for 3 proposed well sites within "Subject Land 2". The Northern Land Council (NLC) issued a Conditions of Work report for the proposed activities in October 2021.This application proposes to seek an Aboriginal Area Protection Authority (AAPA) clearance certificate for a subset of exploration activities within "Subject Land 2" to support Tamboran's ongoing exploration program.

Tamboran requests that an Authority Certificate is obtained via agreement in accordance with s22(1)(b) of the Northern Territory Sacred Sites Act. The agreement forming the basis of this Authority Certificate application are:

- Exploration Agreement: Exploration Permit Application 117 - Borroloola Barkly Region, Northern Territory between Sweetpea Corporation Pty. Ltd. and the Local Aboriginal Groups and the Northern Land Council, as executed by tripartite deed on 23 November 2005;
- Exploration Agreement: Exploration Permit Applications 98 & 99 and Exploration Permit 76 - Borroloola Barkly Region, Northern Territory between Sweetpea Corporation Pty. Ltd. and the Local Aboriginal Groups and the Northern Land Council; as executed by tripartite deed on 24 November 2003.

2 AAPA Certificate Request Scope

Tamboran is submitting this application for an AAPA certificate to cover all works associated with the following work scope within the defined clearance area:

a) Construction, upgrade, use and maintenance of new and existing pastoralist tracks within the cleared area
b) Collection of seismic data within the area, including line clearing, preparation, operation, data acquisition and vegetation reinstatement
c) Construction of approximately 5 hectares of new gravel pits within cleared area to support civil construction and maintenance activities (including preliminary excavation activities at potential locations to determine appropriate material can be extracted)
d) The construction and use of up to 3 exploration well pads, including associated camp pads, laydown yards, helipads, fence lines and firebreaks.
e) Construction of necessary groundwater monitoring and extraction bores on each lease pad, including the utilisation of extracted water to support exploration activities (expected that less than 10 will be required, however, to satisfy environmental and/or other regulatory requirements further water bores could be required and should be accommodated under the clearance certificate noting that total water take will not be impacted by the number of bores ultimately required).
f) Drilling of multiple exploration wells on each lease pad - vertically to a depth of no greater than approximately 4000 metres (4 kilometres), horizontally to a length of up to approximately 3000 metres (3 kilometres), including formation logging, coring, diagnostic fracture injectivity testing (DFIT), and all activities associated with the collection of formation data and maintenance of well integrity.
g) Hydraulic fracture stimulation of all wells.

h) Well testing of all wells, including wastewater storage, gathering (piping), transport, treatment.
i) Flaring during well testing as required.
j) Extraction and use of groundwater and gravel. Indicative groundwater take 450ML/year.
k) Well completion, maintenance, monitoring/surveillance, diagnostic testing and any other well interventions (coil tubing, slickline, completion rig, etc.) activities required for data acquisition/well operations.
l) Plugging, abandonment and/or remediation of wells after data acquisition, testing and monitoring has been conducted.
m) Rehabilitation and remediation of site.
n) Any other minor works ancillary to the abovementioned works including monitoring, operation of camps, laydown areas, chemical and fuel storage, waste management, routine ongoing maintenance and repair of any infrastructure and/or services.

3 Request Area

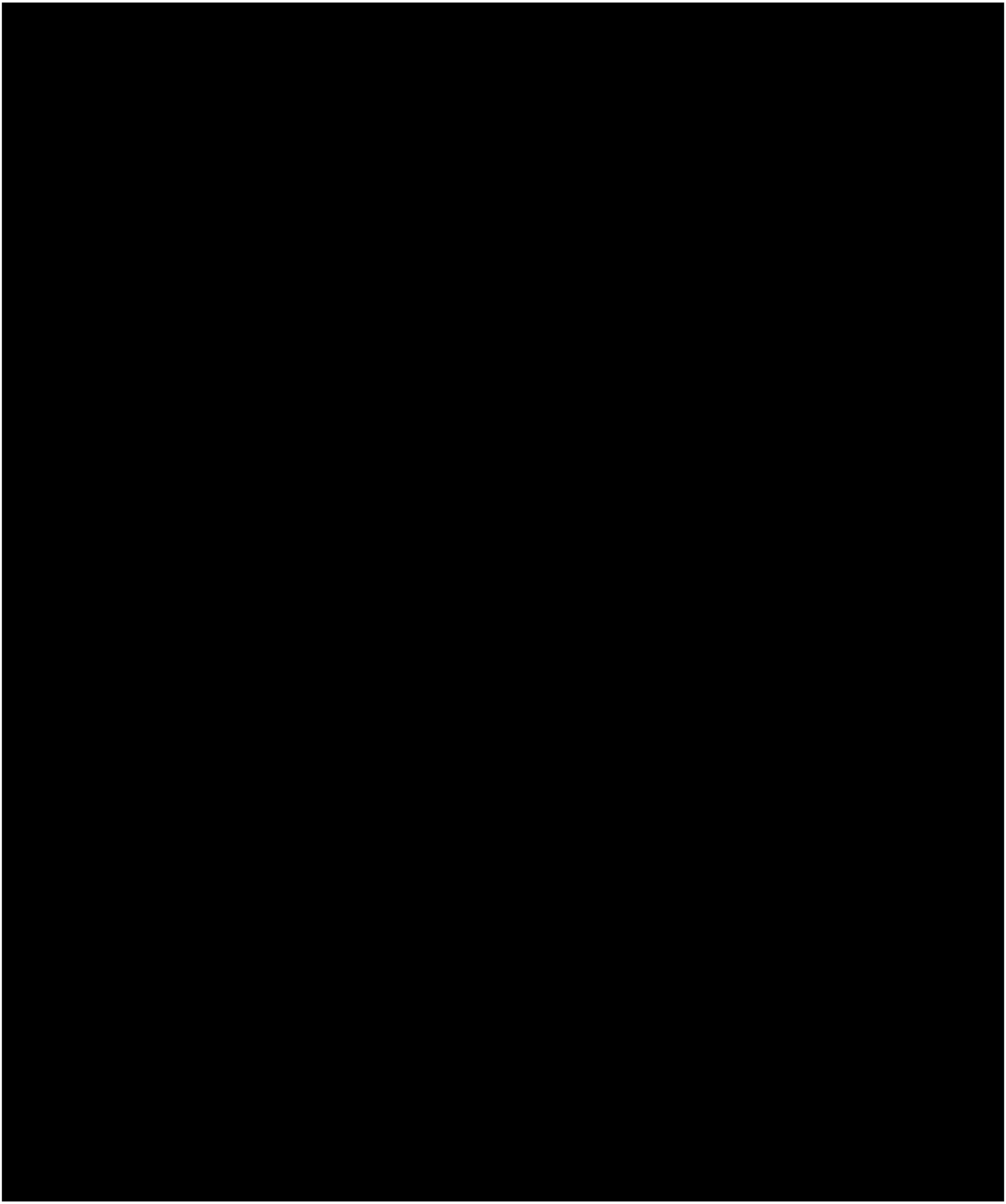
The spatial files for the requested area are provided with this application.

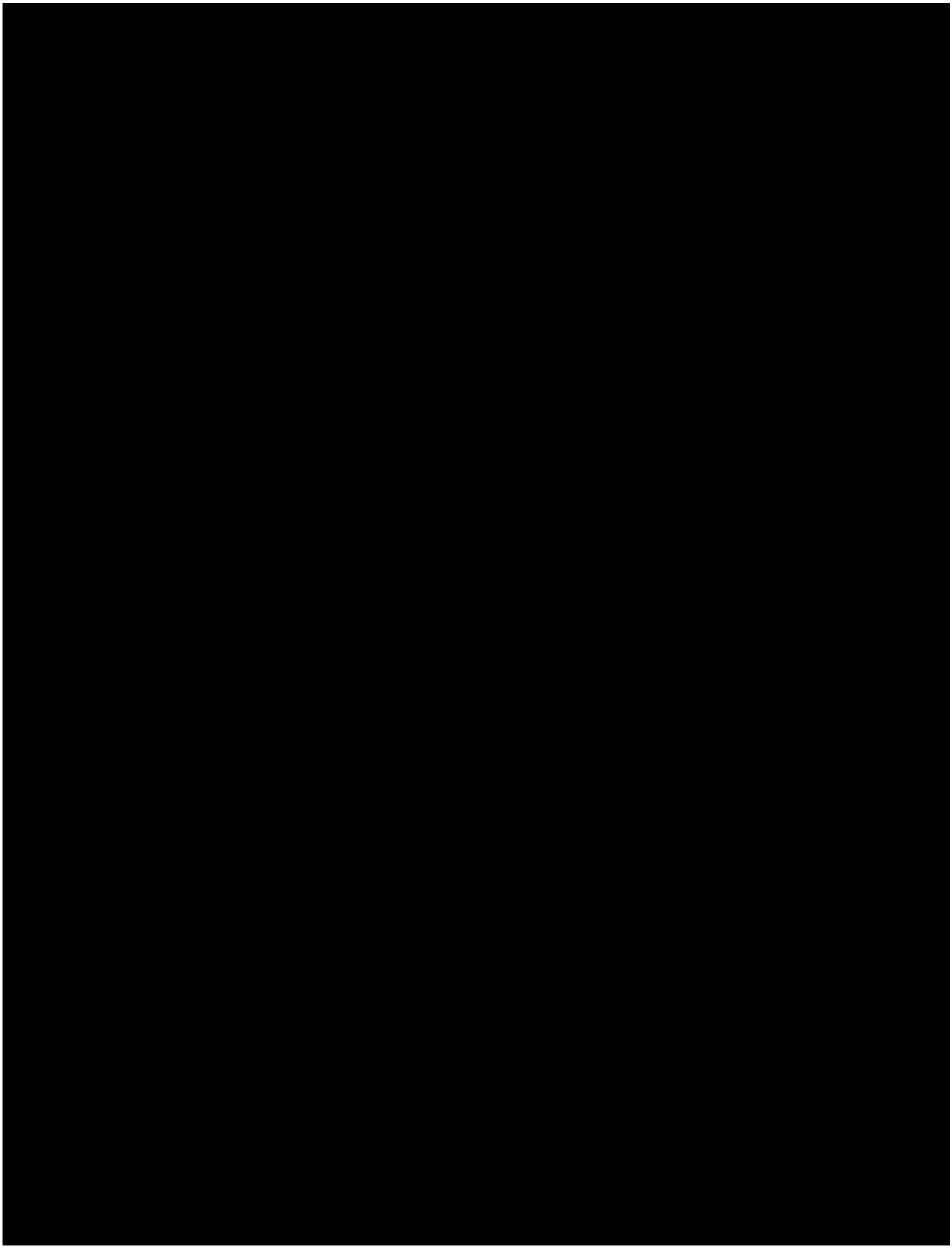
4 Supporting information

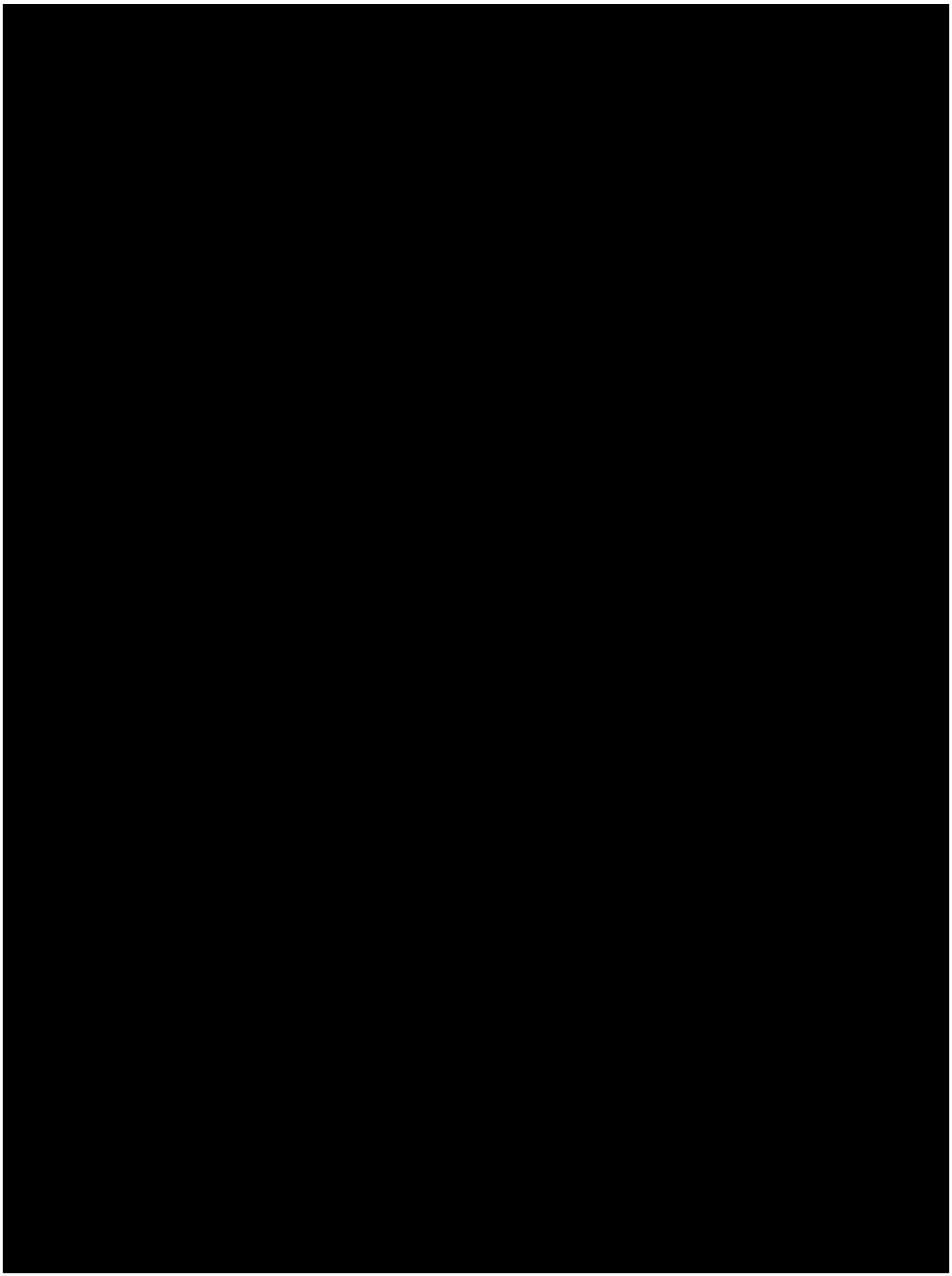
The Beetaloo JV has previously completed engagement with Native Title Holder's covering the proposed scope within the broader "Subject Land 2" area. This scope is covered under the October 2021 NLC Conditions of Work report issued to Origin Energy B2 Pty Ltd (which was acquired by Tamboran B1 Pty Ltd in 2022 and renamed to Tamboran B2 Pty Ltd). The October 2021 condition of Work Report has been provided in Appendix A.

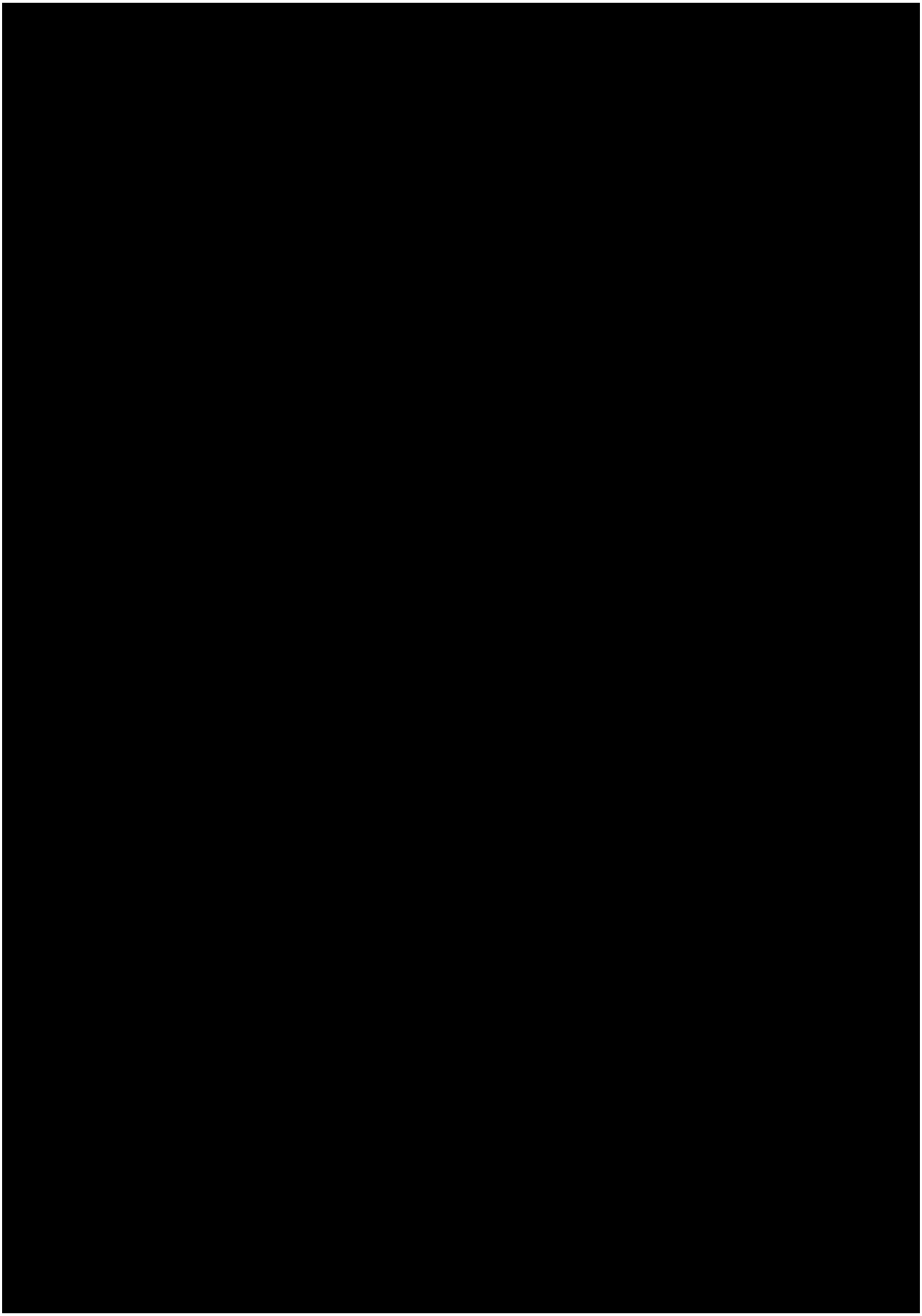
NLC have been informed of Tamboran B2's intention to submit a new AAPA authority certificate to cover the proposed works proposed for Subject Land 2.

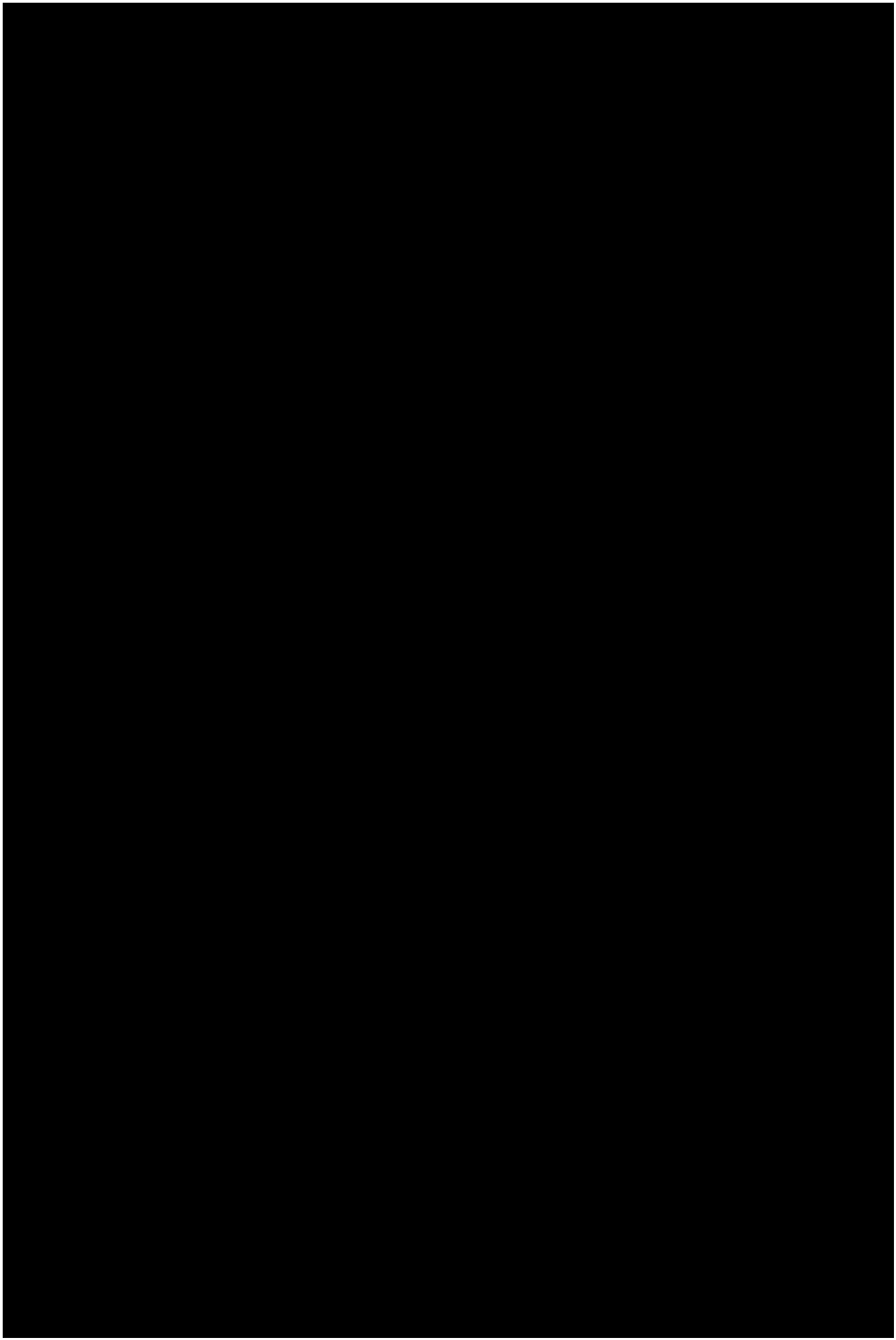
Appendix A- 2021 Sacred Sites Avoidance Survey- Conditions of Work Report

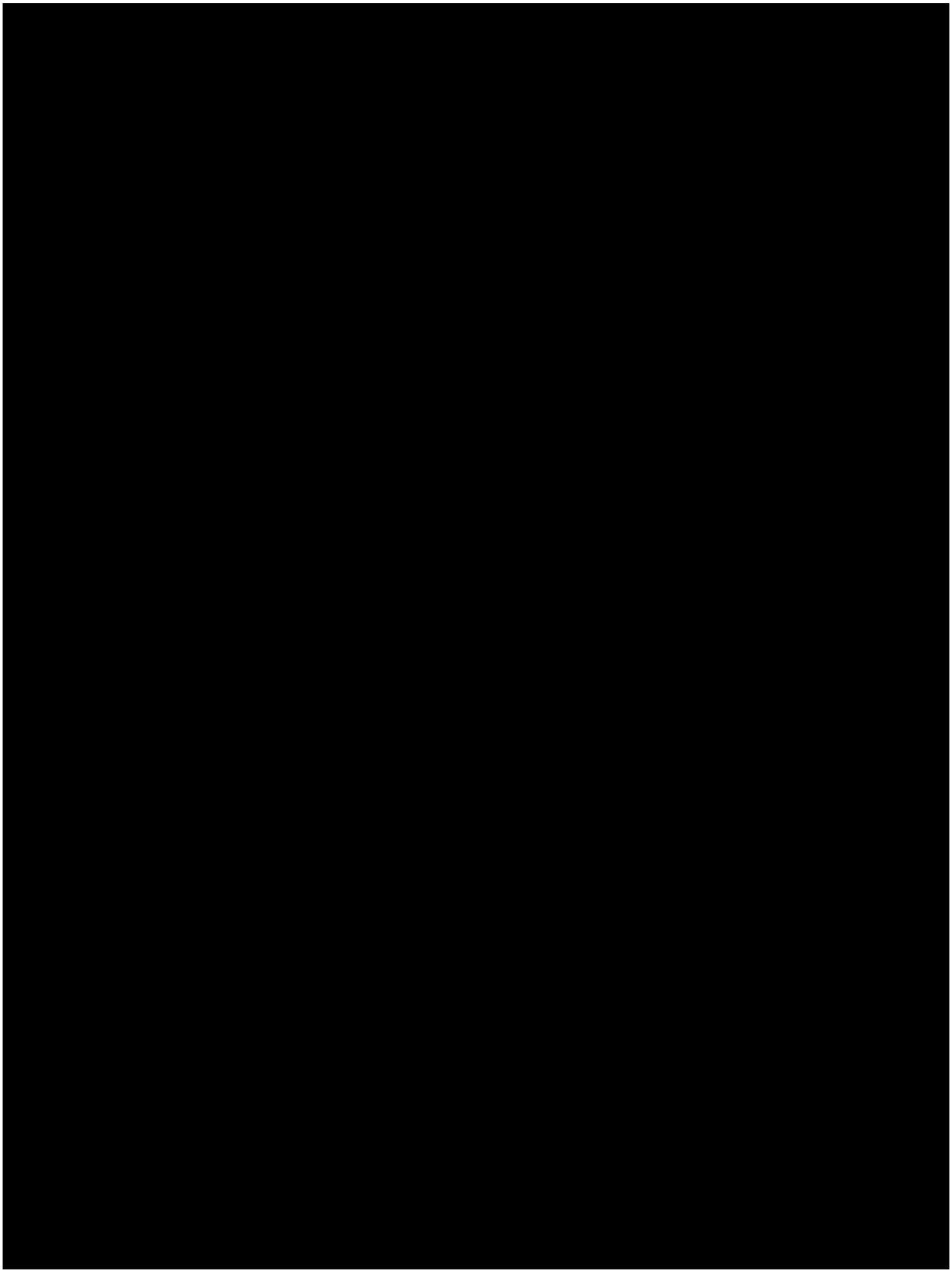


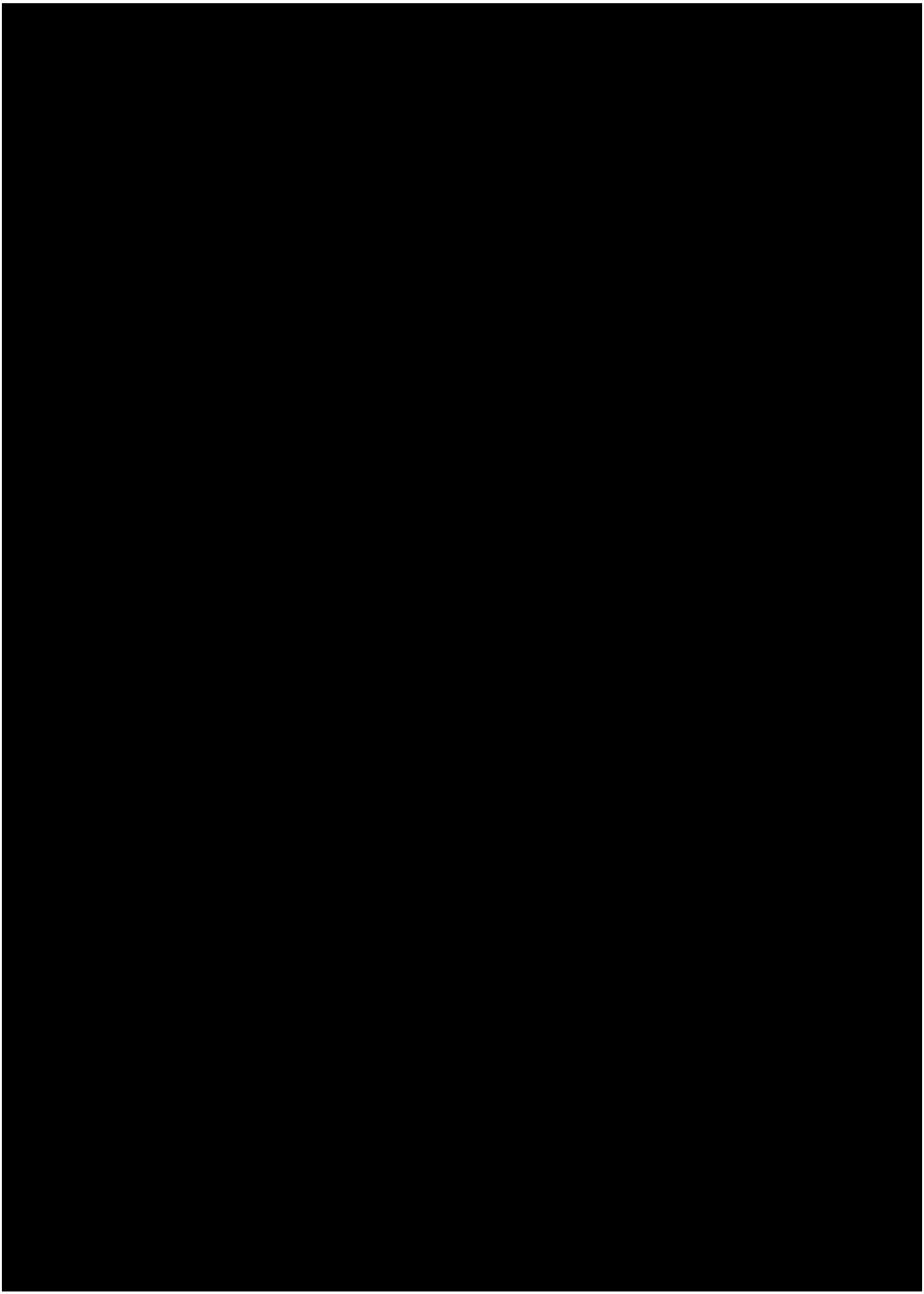












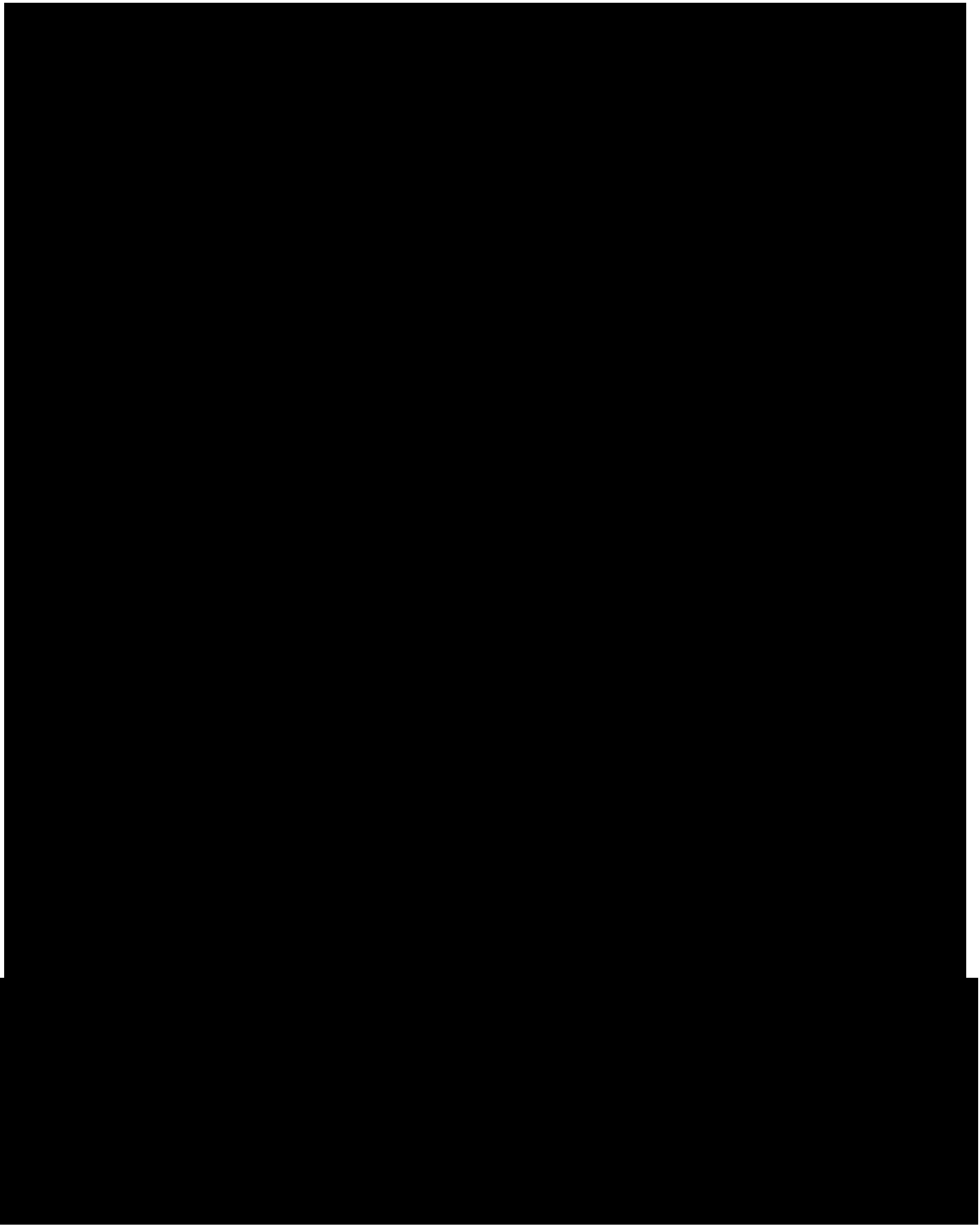
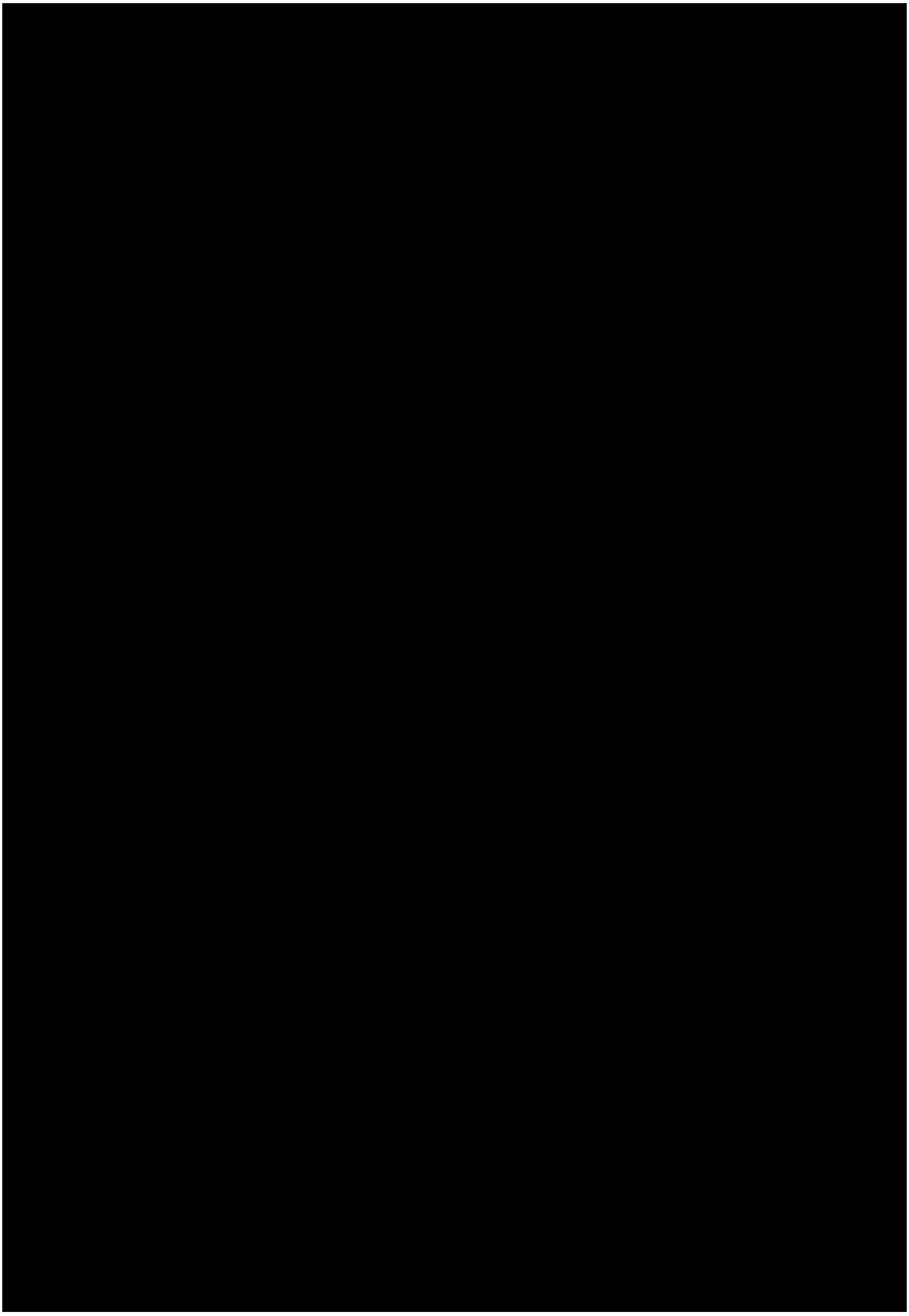
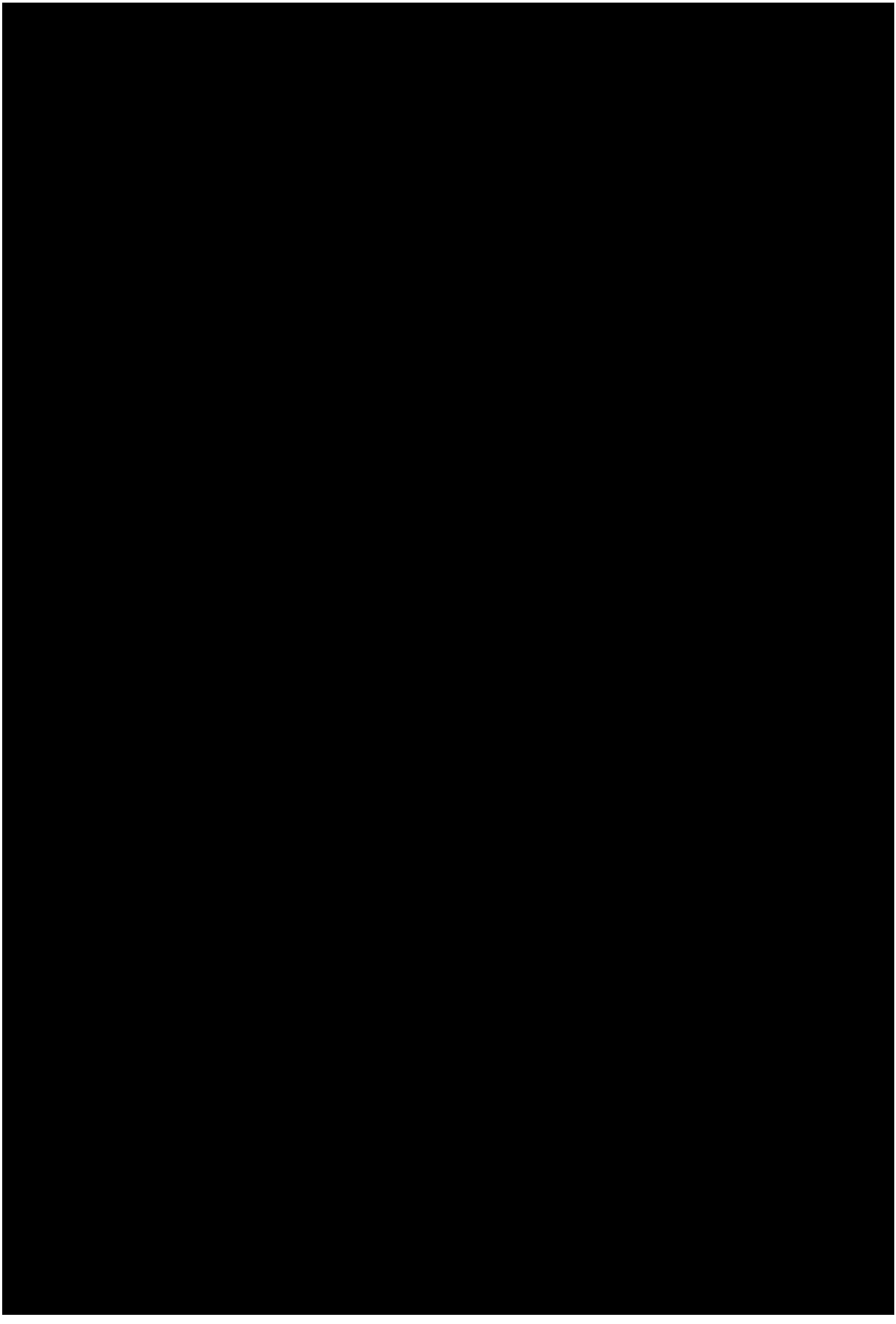


Figure 3. Subject Land 1, RWAs and SNAs.





Annexure A:

2019 Work Program Document provided to the NLC (28 September 2020)

2019 Work Program Clearance Request

(For Potential Exploration Works from 2020)

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon)

Version:	**1.0**
Submitted:	
Presented by:	Origin Energy
Review Date:	November 2019

CONTENTS

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon) 1

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1 OVERVIEW

- Since 2015, Origin has drilled six wells (Kalala S 1, Beetaloo W 1, Amungee NW 1, Amungee NW 1H, Kyalla 117 N2 1, and Kyalla 117 N2 1H) in the Beetaloo Sub-basin (Beetaloo). The Amungee NW 1H well was hydraulically fracture stimulated (HFS) in 2016 (prior to the introduction of a moratorium in September 2016) as part of an exploration work program to assess the potential of hydrocarbons in the Beetaloo (Figure 1).

- In 2018 the moratorium was lifted and in 2019, post the implementation of the NT Inquiry *Exploration Recommendations*, Origin resumed exploration activity in Exploration Permit 117 (EP117) drilling a vertical exploration well, and a horizonal appraisal well targeting the Kyalla formation. HFS is scheduled to be undertaken at Kyalla 117 N2 1H beginning in Q4 2020.

- The approved budget to execute two (2) exploration wells in 2019 was approximately $120 million.

- The full time period for drilling and stimulation is approximately:
  - Drilling: Two (1-4) km deep and two (2-3) km long: Twelve (12) weeks
  - Stimulation (of well with above specifications): Three (3) weeks
  - Production testing: Three (3) months (up to 12 months)
  - Maintenance and monitoring: Ongoing

- Origin's *Northern Territory Government permit commitments* across Exploration Permit 98 (EP), Exploration Permit 76 (EP76) and EP117 (the Permits) require Origin to complete a further four (4) additional exploration wells to be drilled and stimulated.

- Origin's exploration program is designed to identify areas of perspectivity for a potential, future hydrocarbon development.

- Origin respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* of eight (8) potential future exploration locations and access routes (where necessary across the Permits) to comply with the obligations of the Exploration Agreement(s) and to support an application for Aboriginal Areas Protection Authority (AAPA) certification for exploration activity as described below (Figure 2).

2 PROPOSED WORK PROGRAM

- Origin is proposing to drill, HFS and production test four (4) horizontal wells across the Permits over 2019-2022. It is possible that vertical wells will be drilled prior to proposed horizontal wells (that is, a proposed horizontal well would be drilled from a vertical well as occurred for the Amungee NW 1H well).

- Origin may seek approvals to drill, HFS and production test from two (2) to four (4) additional horizontal wells (and associated vertical wells if required).

- Civil works activities to support the exploration program may be undertaken throughout 2020 (note this is likely to include the construction of roads to enable site access along with supporting activities such as accessing aggregate from identified gravel pits, water through registered water bores and the installation of additional water monitoring bores as per the requirements of the NT Inquiry).

- Civil works and associated activities are likely to be undertaken on sites where NLC Clearance and AAPA certification is held to facilitate exploration activity beyond 2020.

- 3D or 2D seismic activity

Origin looks forward to ongoing engagement with the NLC and Traditional Owners across the Permits to ensure annual work programs are communicated clearly and in advance of the commencement of activities.

2.1 Activities

The following activities would be required to complete work across the sites included in this request:

Activities, in approximate order of operation, include:

1. Scouting, surveying, and small-scale surface and shallow subsurface sampling of soils to support geotechnical studies and environmental evaluation.

2. Civil engineering activity to repair, improve and/or construct access tracks and/or unsealed roads and well pads (e.g. grading, excavation, fencing); note this activity may require borrow pits along access routes and close to well pads.

3. Drilling/installation of water bores as required.

4. Exploration drilling (vertical and horizontal wells).

5. HFS (horizontal wells and associated vertical wells if required) (including HFS monitoring equipment).

6. Production testing.

7. Follow-up testing, monitoring and work-over activity (as required).

8. 2D or 3D seismic data collection activity

8. Activities associated to the plugging, abandonment and/or remediation of wells after proper testing and monitoring has been conducted (as required).

9. Any other auxiliary works/activities required under good oilfield and/or environmental practice and accepted project commitments to support foregoing activities.

All exploration activities require Origin to submit an Environmental Management Plan (EMP) for assessment by the Northern Territory Regulator(s), which details how environmental risks and impacts will be managed appropriately. Origin will provide approved EMPs to the NLC as part of our annual submission of documents and is happy to discuss any elements of such EMPs on request by the NLC or host Traditional Owners.

More detailed descriptions of the above activities are provided in Appendix 1 .

2.2 Areas

- The attached maps and digital GIS files detail the location of eight (8) potential sites, and associated access routes requested for Sacred Site Clearance surveying.

    - Sites - the initial clearance request is for an extended polygon providing a radius area area around the proposed location.

- Access Routes - the initial clearance request is for a 100 m buffer zone either side of the access tracks; however, Origin will support a wider clearance area as needed by the NLC and cultural monitors and/or Traditional Owners.

• Once feedback regarding the proposed sites has been obtained from host Traditional Owners, the NLC and relevant pastoral lessees, the documentation will be finalised for review at an On-Country Meeting.

2.3 Request

Origin respectfully requests that the NLC coordinates the following to allow exploration activities to proceed:

a. Sacred Site Clearance survey the proposed sites, and associated access routes (if applicable) as soon as practicable.

b. Coordination of an On-Country Meeting as soon as practicable post the completion of the survey work.

2.4 Figures

Figure 1 Current base map of Origin operated permits and wells drilled to date
Figure 2 Summary of wells drilled to date and current NLC cleared locations
Figure 3 Summary map of additional proposed locations, clearance areas and associated access routes requested for Sacred Site Clearance survey

2.5 Tables

Table 1 Propose site locations for Sacred Site Clearance survey.

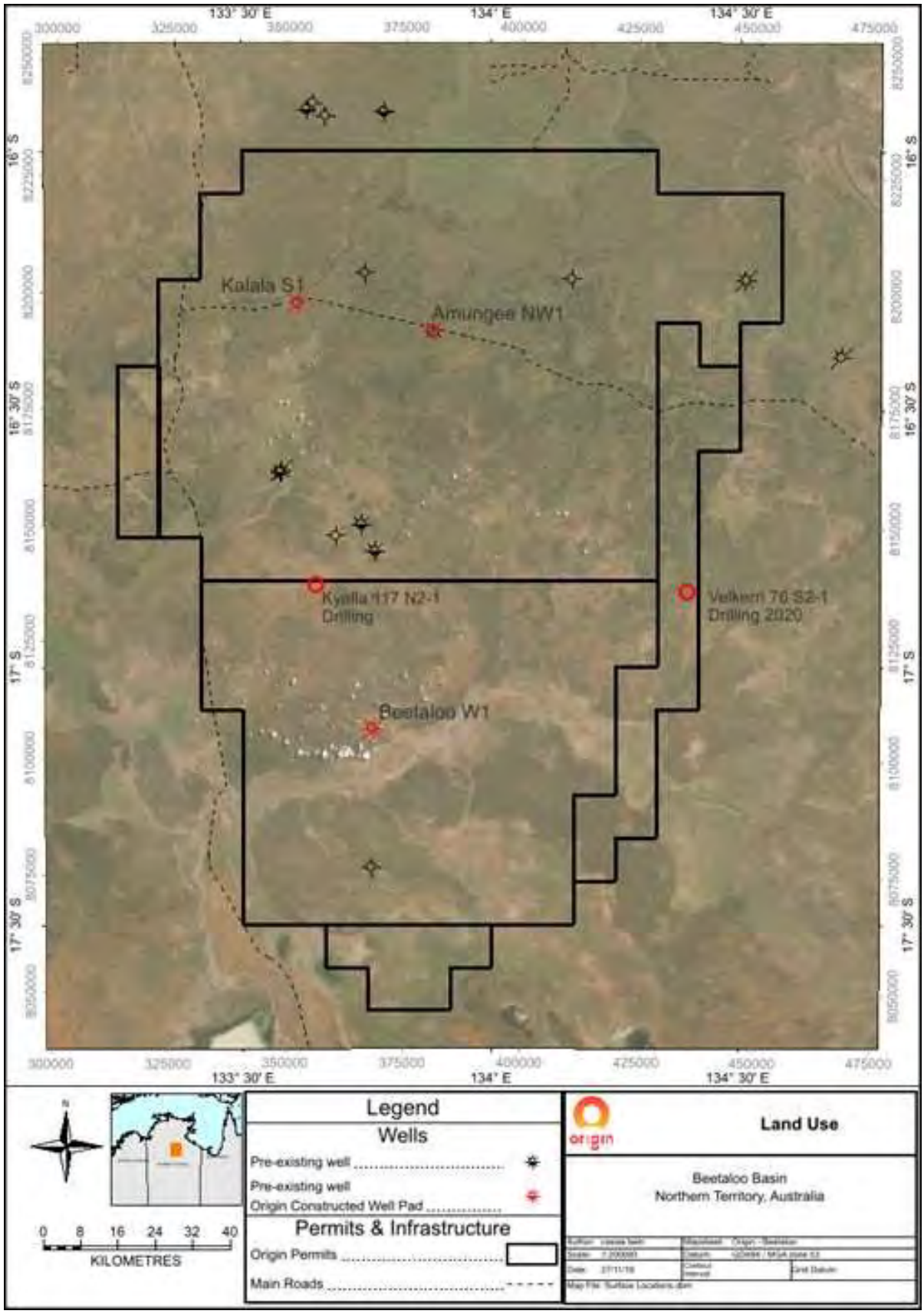
2.6 Appendices

Appendix 1 Indicative Activity Descriptions
Appendix 2 Minimising Environmental Impact

2.7 Attachments

Attachment A GIS files of proposed sites, and access routes requested for Sacred Site Clearance survey.

Figure 1 - Current base map of Origin operated permits and wells drilled to date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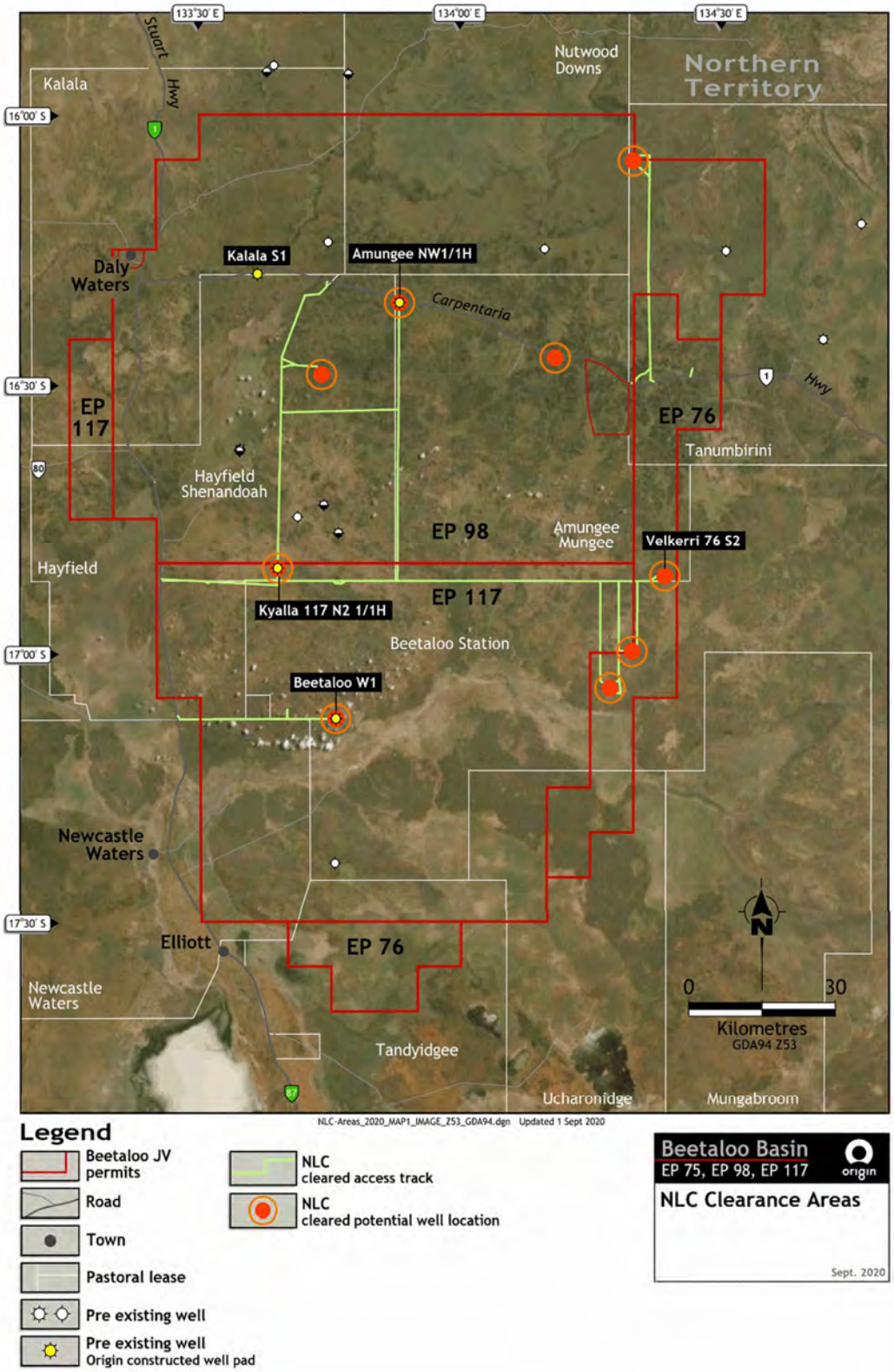
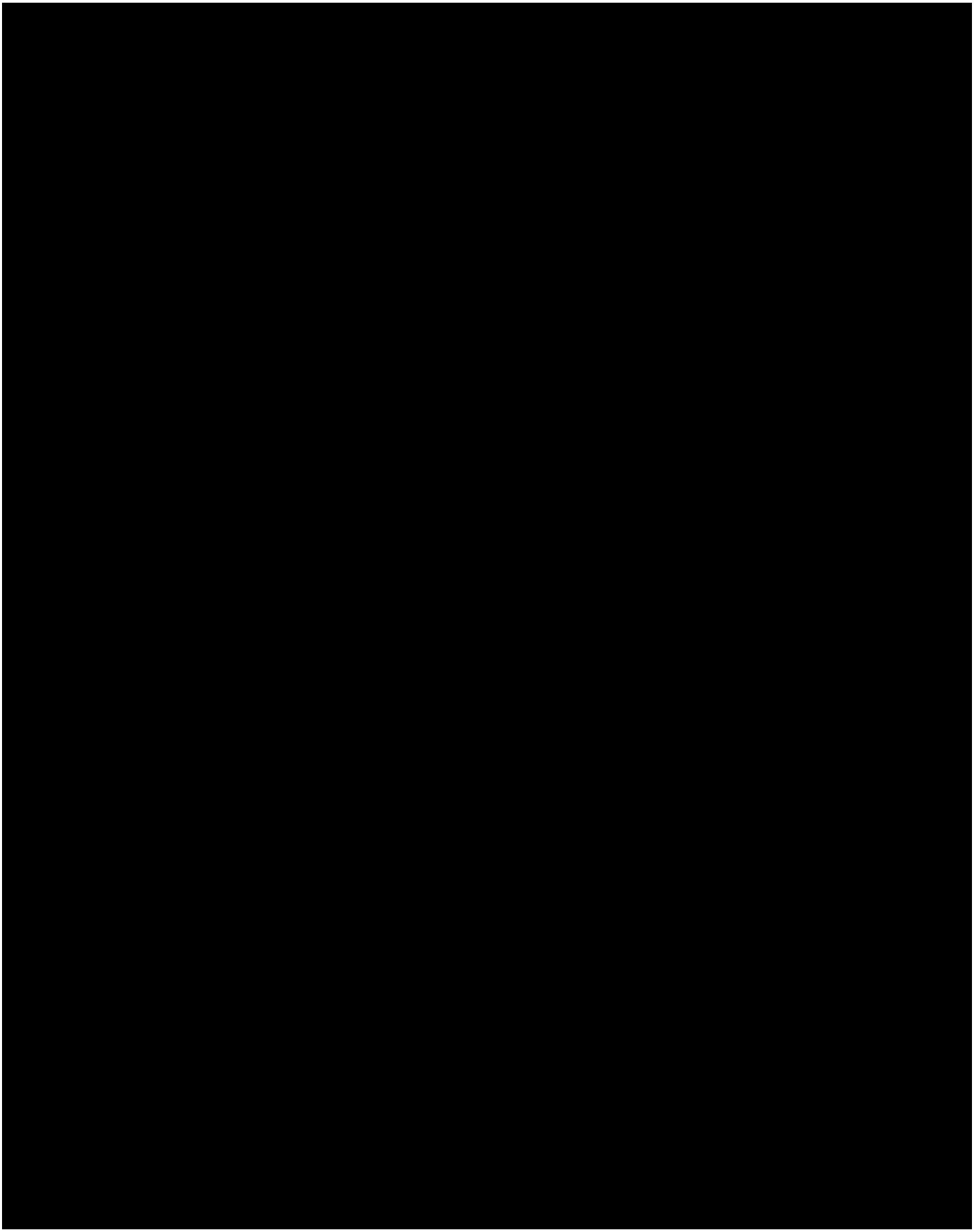
Kalala S1
Amungee NW1
Kyalla 117 N2-1
Drilling
Velkern 76 S2-1
Drilling 2020
Beetaloo W1
N
0 8 16 24 32 40
KILOMETRES
Legend
Wells
Pre-existing well
Pre-existing well
Origin Constructed Well Pad
Permits & Infrastructure
Origin Permits
Main Roads
origin
Land Use
Beetaloo Basin
Northern Territory, Australia

Figure 2 - Summary of wells drilled to date and current NLC cleared locations





3 APPENDICES

3.1 Appendix 1

The following information and table details the typical activities associated with drilling and hydraulic fracture stimulation operations of vertical and/or horizontal exploration well as proposed in the Beetaloo. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and we propose that such departures are covered by the content of this application.

The first step in the exploration well process includes the construction of access roads and where necessary, land clearance to allow access to the potential well-site location. The drilling lease pad itself (ie. the area of land that would be occupied by the drilling rig and support equipment) would consist of approximately one (1) hectare of cleared and site engineered compacted earth. This area would host the drilling rig and all associated equipment as well as a mud sump (i.e. a pit where used drilling fluids would be stored while the operation is in process) and a flare pit (i.e. a pit that can be used to burn any gas or oil encountered while drilling in a safe manner, although it is unlikely to be used). The rig camp would be located within the vicinity of the drilling rig on a cleared area of approximately 100 m x 100 m. A rig camp for this type of exploration activity typically accommodate approximately 50 to 100 people.

All of the above areas would be connected to existing roads with unsealed tracks built specifically for the activity, approximately 6m wide tracks in an 18m wide corridor.

Once the surface infrastructure is in place, a drilling rig and camp would be brought in to undertake the drilling activity. A drilling rig package consists of the main rig package as well as supporting vehicles and pieces of equipment. Origin's host Traditional Owners have visited these types of facilities both at the Beetaloo well pad as well as the Amungee well pad. Generally, some, or all, of the following equipment would be on site during the drilling operation:

- The main drilling rig package consisting of a rig floor, a mast or derrick, and the rig diesel engine.
- Racks for storing drill pipe or casing and potentially a "pipe arm", which is a piece of equipment designed to bring pipe and casing up to the drill floor.
- The rig's drilling fluid system including tanks and pipes for storing and pumping fluid down the drill string.
- An air drilling system consisting of piping and air compressors for directing compressed air down the drill string may also be used.
- Storage trailers and racks for equipment such as mud chemicals, drill pipe, casing, and other equipment used down hole to complete the operation.
- A work/welding shop.
- Portable onsite offices.
- Third party equipment such as cementing trucks and wireline evaluation units would also be required on site intermittently as per operational requirements.

Trucks delivering equipment and consumables (e.g. fuel, food and water) would be travelling to and from the site regularly. There would also be regular light vehicle activity to transfer people between the drilling rig and camp.

Once the drilling rig is rigged up, tested, and functional, a large diameter drill string (also known as the

bottom hole assembly or “BHA”) would be used to drill a ~15-25” hole to a depth shallower than the regional aquifer (depth varies regionally). This section would be drilled with fresh water and “sweeps” (intermittent volumes) of higher viscosity fluid to help remove cuttings out of the hole. A large diameter string of casing would then be set and cemented at this depth.

The drilling rig would then be set up to drill through the aquifers and the Antrim Plateau Volcanics (assuming they are present). At this point a further string of casing would be run and cemented to seal the aquifer off from the rest of the wellbore. A blow out preventer (BOP) would be installed on top of the string of casing and pressure tested. A successful pressure test would ensure the BOP is functioning correctly and confirm the integrity of the casing and cement.

Drilling will then recommence and a few metres into the underlying formation. A test known as a “leak off” test would then be conducted to understand the rock strength; this involves applying just enough pressure to the fluid in the hole to break the formation. The information gained during this test is critical for maintaining the integrity of the hole as it indicates how much pressure can be safely applied to the formation and also the maximum mud-weight that can be used to provide well control. Following a successful test, drilling will proceed to a depth selected by geologists, reservoir engineers and drilling engineers based on subsurface understanding and well objectives. A further string of casing may then be installed and cemented to seal off previous formations, and if so, the casing shoe would then be drilled out and another leak off test conducted.

A KCl/Polymer or Synthetic based fluid system is likely to be the base fluid for drilling. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the bit, and lift drill cuttings to surface. A KCl/Polymer fluid system consists of water with potassium salt (to prevent formation swelling) and a viscosifying agent (usually the naturally occurring mineral bentonite or a starch similar to those used in food manufacturing (i.e. guar gum)). A synthetic based fluid system consists of a non-aqueous fluid base.

The final hole section (referred to as the “production hole section”) covers the hydrocarbon reservoir section(s) and it is drilled to the well total depth (TD). TD is likely to range between 1000-4000 m below the ground surface, with the potential for a lateral section to be drilled horizontally for 1000-3000 m within a target reservoir,depending on the stratigraphic depth and thickness of the zone of interest at a particular location. Drilling activities could also include coring, a process in which a drill bit with a cylindrical opening is used to cut-out rock cores for geological, geochemical and geomechanical studies.

In horizontal wells, the production hole section is drilled with the help of steering tools, which are used to gradually build the inclination so the well penetrates the prospective reservoir zone with a horizontal alignment usually for a total length of 1000-3000 m. In addition, logging while drilling (LWD) tools may be employed to enable measurement of rock properties such as the natural radiation signature or resistivity of the rocks, in order to facilitate identifying key changes in rock type down the wellbore.

Once TD is reached, the BHA is pulled out of the hole and the well cleaned by means of circulation. Following wellbore conditioning, a series of special tools are run down and up the hole to measure various aspects of the reservoir fluids and rocks. This process is known as wireline logging. Wireline logging activities may also include sidewall coring, a process that allows small cores/rock samples to be cut from the side of the hole using wireline tools.

Diagnostic Fracture Injection Tests (DFIT) may be run to further investigate rock properties. The DFIT has become the primary safety and transient test for ultra-low permeability shales. It involves injecting small volumes of water at low rates to create small fractures, allowing the resulting pressure to fall naturally. The fluid contains no proppant hence the fracture relaxes and closes naturally when pressure is released. The pressure decay is monitored onsite and the data acquired is analysed to aid in reservoir characterisation. The DFIT can be carried out while the rig is on site or after the rig has been mobilized.

If the well is to be hydraulically fracture stimulated (HFS), a separate set of specialised equipment, trailers or skid mounted equipment is mobilised to the well location. This equipment mainly consists of high volume/high pressure pumps, mixing equipment, water storage tanks (enclosed and open), and

control and monitoring equipment. This equipment was inspected by host NLC representatives and host Traditional Owners prior to the HFS activities at the Amungee NW 1H well. HFS involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontally drilled wellbores. The pressurised mixture causes the rock (i.e. shale) to crack. The small cracks or fractures created are held open by the sand/proppant allowing hydrocarbons to flow from the shale to the wellbore and up the well. The fractures created are separated from surface aquifers by impermeable rock. Other formations (including surface aquifers) are also isolated behind several layers of steel casing and cement preventing contamination.

After the completion of HFS operations, a production test is typically carried out for a period required to assess the potential of the well and acquire important reservoir and hydrocarbon data (Origin proposes to test wells for a minimum of three (3) months, and may seek to extend this for the final wells in the 2021 and 2022 work program to up to 12 months).

Once all drilling, wireline and testing operations are completed a decision is made to either safely suspend the well (e.g. for further testing in the future) or to plug and decommission the well. If the well is suspended, all suspension operations and procedures are conducted in accordance with regulatory requirements and industry best practise. This includes maintaining and conditioning the surface well pad, as well as site rehabilitation after well decommissioning and ongoing monitoring.

The plug and decommissioning process includes setting cement plugs in the hole to isolate permeable zones and prevent cross flow between different rock layers exposed by the drilling process. A cement plug would also be set across the open hole section and previous casing and pressure tested to ensure it acts as an effective fluid barrier to surface. Another plug would be set inside the casing prior to removing the BOP and cutting the casing off at surface. Finally, cement would be poured into the casing stump at surface and a plaque installed to identify the decommissioned well.

The drilling rig and all associated temporary equipment would be then removed from the site. If the well has been plugged and decommissioned, all disturbed areas (e.g. lease pad, pits, camp area) would be rehabilitated and re-vegetated. The only infrastructure that would be kept includes water bores (potentially for monitoring and / or for pastoralist's use) and any roads required to access them.

Table A - Summary of Exploration activities.

Activity	Description	Equipment	Duration
Water Bore / Civil Works	Installation of a water bore and water tanks, levelled areas for rig and camp, pits for fluid storage and roads for access.	Earth moving equipment and water bore drilling unit.	Approximately 1-2 months and potentially completed some months prior to drilling activity.
Exploration Drilling	Drilling with air/water to install progressively smaller cemented casing strings to ultimately reach the target rock formations and well TD	A drilling rig package (described above) as well as associated heavy and light vehicles.	Approximately 30-90 days (highly variable, especially in exploration phase and will depend on whether a horizontal section is required).

Evaluation	Running wireline tools to tests various properties of the reservoir rocks once they have been drilled into.	As well as the drilling package, there would be a wireline logging truck and a variety of industry standard tools.	Approximately 2-3 days, depending on success of testing.
DFIT	The DFIT involves injecting small volumes of water at low rates to create small fractures in the rock and then allow the pressure to fall naturally.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps and control, and monitoring equipment.	Approximately 2-3 days.
HFS	Hydraulic Fracture Stimulation involves the injection of large quantities of water and sand plus a small percentage of chemicals at high pressure down and across horizontal drilled wellbores causing the shale to crack. The cracks or fractures created are held open by the sand/proppant allowing gas from the shale to flow into and up the well.	Specialised truck, trailer or skid mounted equipment mainly consisting of high volume/high pressure pumps, mixing equipment, water storage tanks and control and monitoring equipment.	Approximately 10-30 days depending on the number of stages to be fracture stimulated.
Completions Activity	Equipment installation inside the wellbore, typically steel tubing to assist the well's ability to lift fluids/gas up the wellbore to surface.	A completions rig package and wireline units when required	Approximately 2-5 days
Production Test	Measuring the productivity of the wellbore after it has been HFS. Flow rates (gas/fluids), pressures, solids, and gas/fluid analysis are typically assessed.	Well test package, typically consisting of a 3 phase test separator, choke manifolds, flowback tanks, flare stacks and emergency shutdown valves. Wells that require artificial lift to initiate flow may also have a coiled tubing unit on location to conduct a Nitrogen (N_2) lift.	Approximately 1-12 months.

Plug and Decommissioning (activity delayed if well is suspended)	Setting and testing cement plugs to ensure permeable zones have been isolated from each other to prevent cross flow and/or flow communication to surface.	A drilling rig package.	Approximately 2 days.
Site Rehabilitation (after Plug and Decommissioning)	Earth works rehabilitation to original condition. Re-vegetation as required. Note that any water bore and some road access are likely to remain.	Earth moving equipment.	Approximately 1 week (TBA) and then sufficient time to re-establish vegetation. May be completed several months post drilling activity.
2D or 3D seismic	Collection of seismic data by placing seismic nodes on the ground surface and then creating pulse energy into the subsurface which reflects off changes in rock layers 'hardness' and are detected by the nodes when the reach surface again. This allows an 'image' of the subsurface to be collected which allows predictions on what rocks occur underneath the exploration area	Vibroseis trucks, Seismic nodes and associated cables	2 - 12 weeks

3.2 Appendix 2

Included in submissions are comprehensive environmental management plans (EMP) detailing processes and procedures that will be followed during implementation and execution of all aspects of exploration activity. These plans are also assessed and reviewed as part of the ATD process to ensure field activities are carried out in a way that meets all applicable environmental legislation and regulation. An EMP and associated documentation, assessed as part of the ATD approval, may include:

- Management of Sacred Site / Cultural Heritage, heritage, bushfire, weed control and management, erosion and sediment control, protection of Surface water and groundwater water, dust, traffic, biodiversity, and waste) - these plans will cover both the general exploration activity plus specific environmental requirements for each well site and its associated activities
- Oil Spill Contingency Plan (OSCP)
- Emergency Response Plan (ERP)
- Water Management Plans for regular testing of local water bores before, during, and after the project
- Chemicals disclosure – a list all chemicals to be used during the project
- Environment Rehabilitation Security Bond - submission of security bond calculation that covers all the rehabilitation management areas and evidence of final payment
- Archaeological, Sacred Site and Heritage clearance
- Pastoralist's consent

Copies of all documentation including all Environmental plans and documentation provided to Northern Territory regulatory agencies will also be provided to the NLC. All activities carried out by Origin as operator are also governed by stringent internal environmental policies and directives which are referenced when preparing environmental plans and undertaking work programs.

If hydraulic fracture stimulation is to be undertaken, the following additional environmental controls are also applied:

- Further validation of cement placement and its integrity
- Further pressure testing
- Continuation of baseline water monitoring and testing
- Submission of fracture modelling (maximum propagation height), confirming safe separation between any natural aquifers and the fracture zone
- Submission of all MSDS for public disclosure on the department's website
- BTEX (Benzene, Toluene, Ethyl-benzene, Xylene) products will not be accepted nor utilised as they are prohibited for use in the Northern Territory.

Origin has in place an HSE Policy that states:

At Origin, we value the wellbeing of our employees, contractors, customers, the communities in which we operate and the environment. We are committed to responsible management practices that minimise any adverse health, safety or environmental impacts, and enhance benefits associated with our activities, products or services.

We have in place a Health, Safety and Environment management system for our activities that drives continual improvement. The HSE Management System outlines accountabilities to implement this Policy and requires that we:

- Identify hazards and reduce risks so far as is reasonably practicable where there is potential to cause injury or illness to people, or to adversely impact the environment or the community
- Provide safe work places and systems of work, empower employees and contractors to address unsafe or hazardous situations and carry out their work in a manner that does not present a risk to themselves, others or the environment
- Support the recovery and rehabilitation of employees in the event of work related injury or illness
- Set objectives and targets which promote the efficient use of energy and resources, the minimisation of wastes and emissions and the prevention of pollution
- Comply with relevant HSE legal requirements and other commitments
- Require Contractors to manage HSE using standards and practices that accord with this Policy
- Regularly review and report HSE performance.

In implementing this Policy, we will engage with our employees, contractors, suppliers, business partners, customers and Government and communicate expectations to all persons working with or on behalf of Origin.

Origin field activities are also covered by a series of Environmental Directives which include the following:

- The Air Emissions directive outlines Origin's requirement for identification and management of emissions with potential to affect air quality and/or regulatory compliance.
- The Biodiversity Management directive describes requirements for identification and assessment of impacts on terrestrial and aquatic flora, fauna and ecosystems; controls for managing biodiversity-related risks; and methods for enhancing biodiversity values.
- The Cultural Heritage directive covers identification and assessment of cultural heritage values and sites, compliance with legal obligations and voluntary commitments, development of plans, and effective stakeholder engagement.
- The Environmental Noise directive describes requirements for identifying, assessing, monitoring and minimising noise emitted during normal operations as well as during construction, commissioning and decommissioning activities.
- The Greenhouse Gas and Energy Efficiency directive sets out requirements for managing greenhouse gas (GHG) emissions and energy efficiency, including identification and monitoring of energy consumption, energy production and GHG emissions.

- The Land Management directive describes requirements for identifying and assessing impacts to land, and implementing controls to manage erosion, visual amenity, contaminated sites, site closure and rehabilitation.

- The Materials and Waste directive outlines requirements for identifying, assessing and managing impacts associated with use of materials, and storage, handling, treatment and disposal of wastes.

- The Water Management directive outlines requirements for managing water extraction and consumption, water quality and controlling wastewater treatment and discharges.

Proposed Water, Gravel or other Resource Use

It is proposed that water bores to provide water for civil construction, well drilling and completion operations are to be installed adjacent to the well site pad and along access tracks within the clearance area of the well sites and access tracks. The bores will be constructed to the minimum construction requirements of the NT Government.

Gravel from existing gravel pits and new borrow pits may be required for access road sheeting and well site pad sheeting. Any new borrow pits would be located within the clearance area along the access tracks or lease pads.

Annexure B:
2021 Work program Document provided to the NLC (24 September 2021)

2021 Work Program Clearance Request

(For Potential Exploration Works from 2022)

EP98, 117, 76 – Beetaloo Joint Venture (Origin / Falcon)

Version:	**1.0**
Submitted:	
Presented by:	Origin Energy
Review Date:	September 23 2021

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1 OVERVIEW

Origin's *Northern Territory Government permit commitments* across Exploration Permit 98 (EP), Exploration Permit 76 (EP76) and EP117 (the Permits) require Origin to complete ongoing exploration wells to be drilled and stimulated. Since 2015, Origin has drilled six wells (Kalala S 1, Beetaloo W 1, Amungee NW 1, Amungee NW 1H, Kyalla 117 N2 1 and Kyalla 117 N2 1H) in the Beetaloo sub-basin (Beetaloo), with a seventh well (Velkerri 76 S2 1) underway in September 2021. Results collected from Origin's Beetaloo exploration program have highlighted the various shales within the Beetaloo are potentially suitable for a future shale development. Origin's exploration program is therefore designed to further investigate and delineate these areas of potential perspectivity.

The Amungee NW 1H well (Figure 1). was hydraulic fracture stimulated (HFS) in 2016 (prior to the introduction of a moratorium in September 2016) with the initial results demonstrating a potential recoverable shale resource. Origin recently completed a series of additional tests on the Amungee NW 1H well, which has prompted Origin to undertake ongoing activities in this area to further delineate and expand the understanding of this potential resource.

Origin respectfully requests the Northern Land Council's assistance to facilitate a *Sacred Site Clearance Survey* of two (2) potential future exploration areas (Figure 3) to comply with the obligations of the Exploration Agreement(s) and to support an application for Aboriginal Areas Protection Authority (AAPA) certification for exploration activity as described below.

This application is designed to provide coverage for Origin's current proposed activities within these area over the next 1-5 years, with all or a subset of the proposed activities likely to occur.

2 PROPOSED WORK PROGRAM

The proposed work program for **each of the clearance areas** can be summarised as:

- **Acquisition of 200km^2 of 2D and/or 3D seismic** acquisition utilising potentially various seismic sources (small dynamite charges or vibroseis)
- **Civil construction** of up to 4 well pads and associated infrastructure (water bores, access tracks, gravel pits, camp pads, laydowns, helipads etc.)
- **Drilling, hydraulic fracture stimulating, completing and well testing** up to 8 wells per lease pad
- **Operation and maintenance** of all infrastructure
- **Decommissioning and rehabilitating** all infrastructure.

Origin looks forward to ongoing engagement with the NLC and Traditional Owners across the Permits to ensure annual work programs are communicated clearly and in advance of the commencement of activities.

2.1 Detailed Activity List

The following activities would be required to complete works within **each of the clearance areas** included in this request:

1. Scouting, surveying, and small-scale surface and shallow subsurface sampling of soils to support geotechnical studies and environmental evaluation.
2. Acquisition of 200km^2 of 2D and/or 3D reflection seismic surveys, including line preparation and land clearing activities.
3. Civil construction activities, including the construction of:
    - 4 additional 7.5 hectare lease pads to accommodate exploration well drilling, stimulation and testing activities
    - 4 additional 1.2 ha camp pads adjacent to each of the 4 lease pads to accommodate personnel during exploration activities.
    - 4 additional 1 ha helipad adjacent to each of the 4 lease pads
    - Construction and operation of up to 5 gravel pits, with a total disturbance of 15

hectares

- Construction of up to 5 hectares of Laydown/storage areas within the disturbance
- Construction of access tracks to connect all lease pads and infrastructure to the Carpentaria highway
- Construction of firebreaks around infrastructure
- Construction of fence lines and gates around infrastructure

4. Temporary worker camp construction and operation
5. Drilling of up to 6 groundwater monitoring / extraction bores and associated extraction and usage of groundwater at each of the 4 lease pads
6. Drilling of up to 8 petroleum wells per lease pad, including the vertical and horizontal components.
7. Hydraulic Fracture Stimulation (HFS) of all petroleum wells
8. Well testing of petroleum exploration wells, including flaring, beneficial usage of gas and wastewater storage and treatment
9. Electricity generation onsite, including from diesel or gas fired generators
10. Subsurface diagnostic tests and data collection (including diagnostic fracture injection tests (DFIT), Cement bond logging (CBL), production logging tools (PLT), gas and water bound tracers etc.)
11. Microseismic monitoring during HFS activities
12. Onsite offices, workshops, amenities, and storage areas required to support activities
13. Storage and treatment of drilling fluids and wastewater onsite
14. Onsite disposal of drilling cuttings and muds through onsite encapsulation or mix bury cover
15. Routine site (surface) monitoring and maintenance
16. Routine well inspection, monitoring and maintenance
17. Suspension and/or abandonment of the wells
18. Rehabilitation of disturbed areas (lease pad, camp pad and access tracks)
19. All activities required to support the above (such as bulk chemical storage and use, bulk fuel storage and use, waste management, equipment and materials transport, helicopter movements, monitoring, maintenance etc).
20. All activities to allow good oilfield practise in support of the above activities

It should be noted that the proposed activities are likely to occur over a 5-year period. It is also anticipated that not all of the activities will be undertaken.

All exploration activities require Origin to submit an Environmental Management Plan (EMP) for assessment by the Northern Territory Regulator(s), which details how environmental risks and impacts will be managed appropriately. Origin will provide approved EMPs to the NLC as part of our annual submission of documents and is happy to discuss any elements of such EMPs on request by the NLC or host Traditional Owners.

More detailed descriptions of the above activities are provided in Appendix 1.

2.2 Areas

The attached maps (Figure 3) and digital GIS files detail the location of two (2) potential activity areas, requested for Sacred Site Clearance surveying.

Once feedback regarding the proposed sites has been obtained from host Traditional Owners, the NLC and relevant pastoral lessees, the documentation will be finalised for review at an On-Country Meeting.

2.3 Request

Origin respectfully requests that the NLC coordinates the following to allow exploration activities to proceed:

a. Sacred Site Clearance survey the proposed sites, and associated access routes (if applicable) as soon as practicable.

b. Coordination of an On-Country Meeting as soon as practicable post the completion of the survey work.

2.4 Figures

Figure 1	Current base map of Origin operated permits and wells drilled to date
Figure 2	Summary of wells drilled to date and NLC cleared locations to date
Figure 3	Summary map of two additional proposed activity areas requested for Sacred Site Clearance survey

2.5 Appendices

Appendix 1	Indicative Regulated Activity Descriptions
Appendix 2	Environmental Management

2.6 Attachments

Attachment A	GIS files of proposed sites, and access routes requested for Sacred Site Clearance survey.

Figure 1 - Current base map of Origin operated permits and wells drilled to date

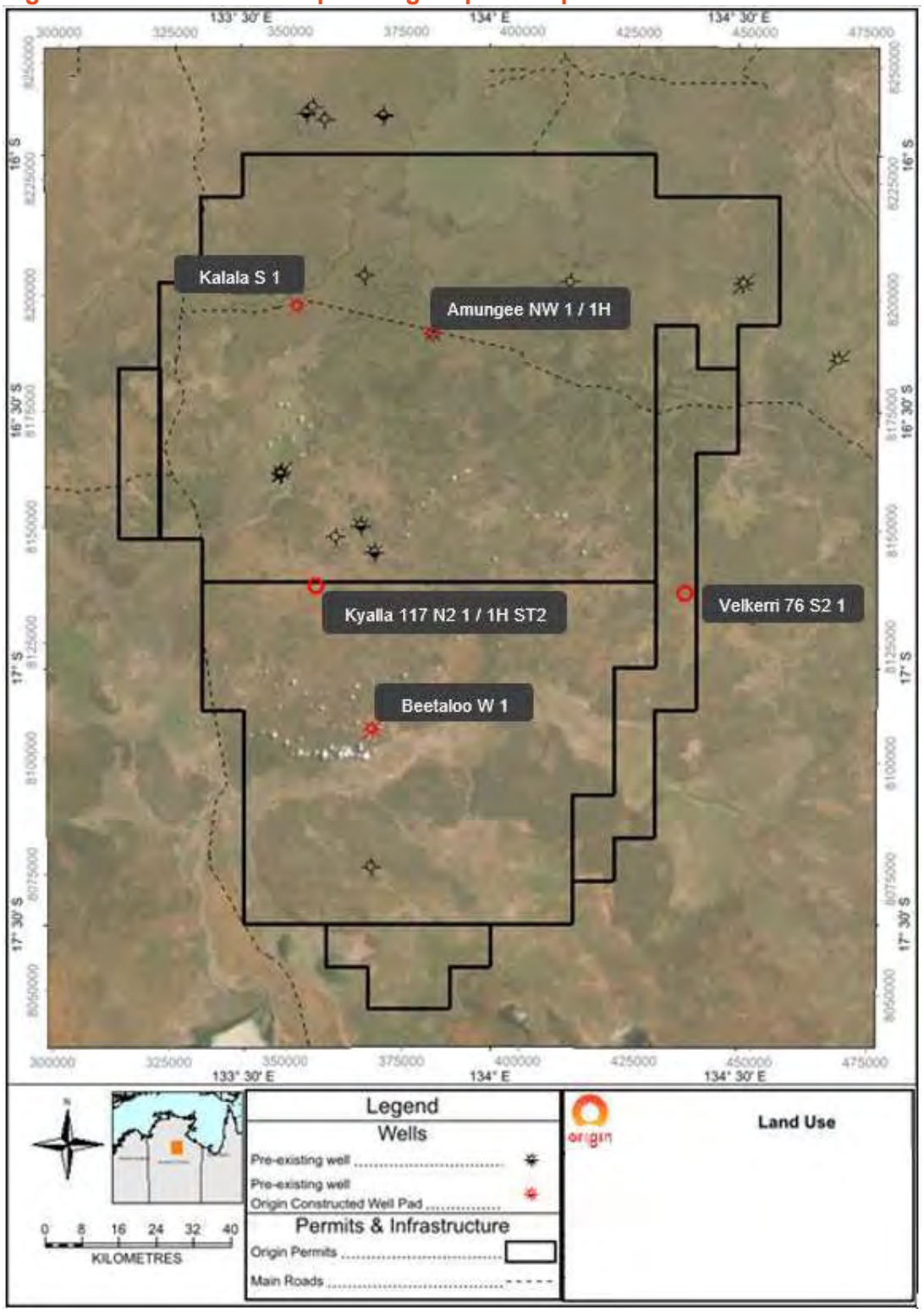
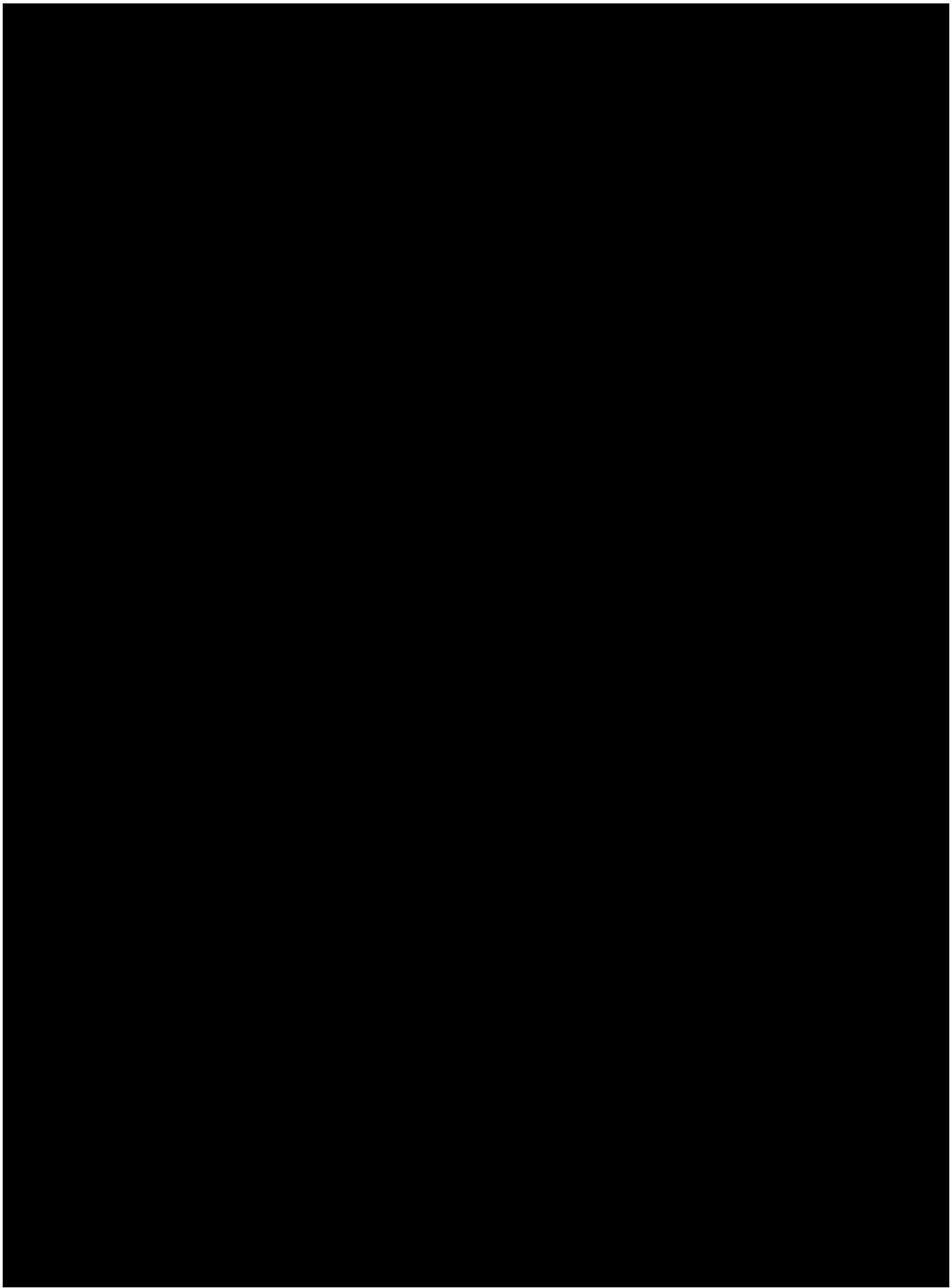
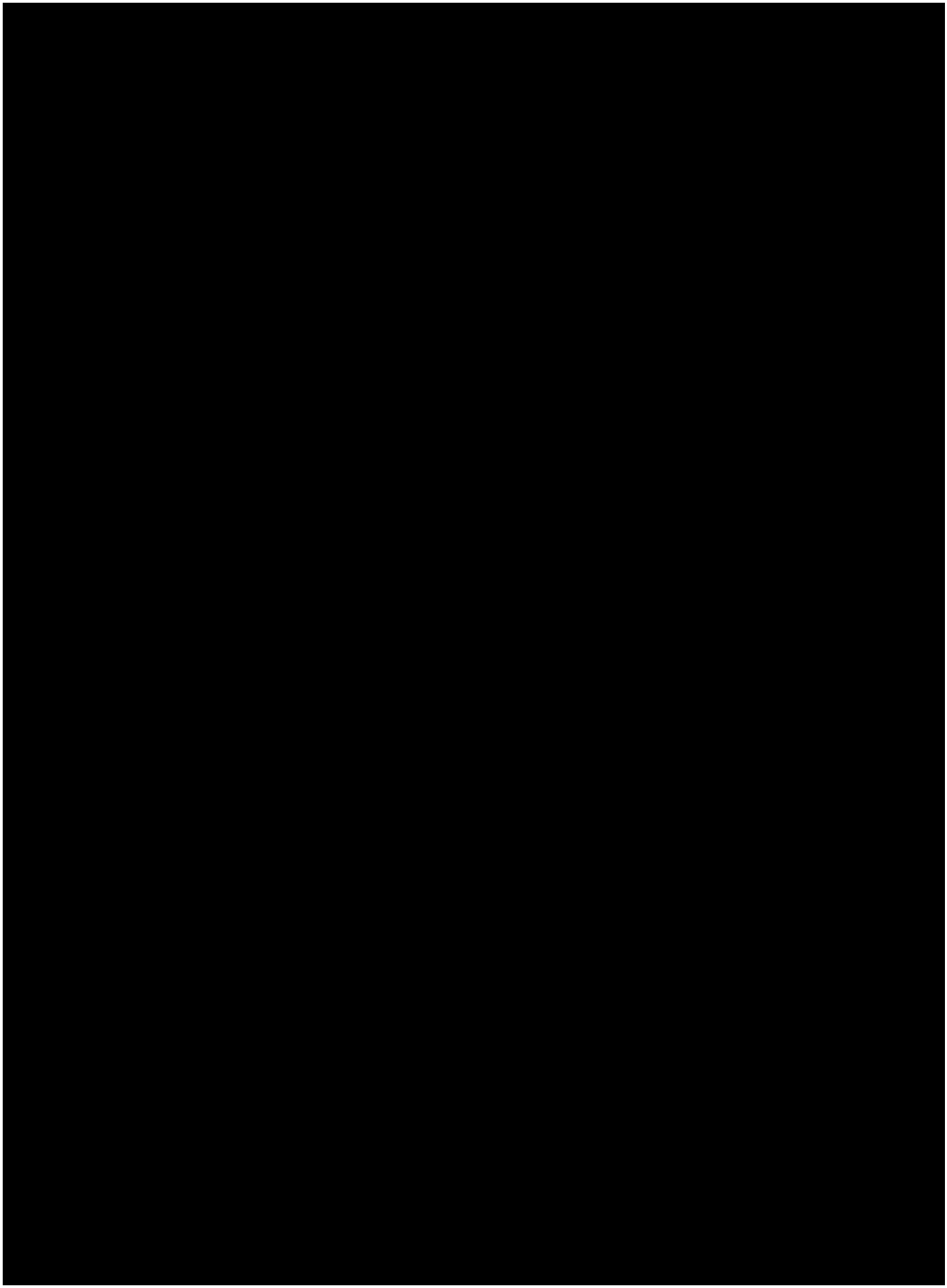


Figure 1 - Overview of Origins Beetaloo Basin Exploration permits and existing wells drilled to date





3 APPENDICES

3.1 Appendix 1

The following information and table details of the proposed exploration activties proposed **w** **ithin each** **of the proposed clearance areas**. These descriptions are indicative and general in nature, minor departures from such descriptions are likely to occur and such departures are covered by the content of this activity description.

Site scouting and assessment

The first step of the process when undertaking exploration activities is site selection. Proposed sites are chosen based upon their assessed chances of exploration success and are ranked as either a priority site (highly prospective) or a contingent site (if a priority site is unavailable due to a constraint). The selection of a site from a subsurface point of view, is often based upon existing exploration information (or lack of), such as seismic data, inferred resource depth (within the oil generating window for example) and previous drilling results. It also includes an assessment of geohazards, such as known major faults or structural features. Once a location has been proposed, each site is assessed for suitability using a multi-criteria analysis. This analysis covers a number of disciplines, including cultural, environmental, pastoralist, regulatory and constructability requirements. Once proposed sites have been identified, each site is assessed using a desktop screening process covering the following:

- Cultural constraints- sites are chosen to avoid known sacred sites and other restricted areas identified through previous NLC field clearance reports, AAPA certificates or heritage mapping.
- Environmental constraints- proximity to sensitive ecological features such as water courses, flood heights, high conservation areas, threatened species and habitats and sensitive soil units
- Leaseholder constraints- proximity to existing pastoral infrastructure and activities, such as cattle yards, fence lines, access tracks, water supply networks, water bores, homesteads and laneways. At this stage, leaseholders are engaged to ensure early input into the location of potential exploration sites. Activities also considers timing constraints such as mustering.
- Regulatory constraints- proximity to water bores, well pad spacing, landscape amenity and proximity to roads and communities.

The number of sites are re-ranked and potentially eliminated based upon their constraints assessment. A revised list of sites will then undergo field “scouting”, to further assess their suitability. Scouting involves assessment by a number of different specialists with a “scouting party”. Scouting activities include:

- NLC field clearance-Origin submits its proposed work program to NLC annually and then initiates field clearance surveys. Traditional owners are then engaged by the NLC and inspect all sites to determine the potential for sacred sites or other areas of cultural significance in the vicinity of the activity. A final report is submitted to AAPA by NLC to generate AAPA certificates which outline the activity constraints and no -go areas.
- Environmental- areas are inspected by ecologists to ground truth for areas of potential high conservation, evidence of threatened flora and fauna, overland flow paths, drainage lines, soil erosion susceptibility, areas of high habitat value (such as large hollow bearing trees) buffer zones (from high conservation value areas) and future rehabilitation constraints, . The infrastructure (including access tracks, lease pads and associated infrastructure) is orientated to minimise clearing (such as picking open woodland rather than dense Bullwaddy or Lancewood communities) and impacts on overland flow. A land condition assessment is completed for the proposed sites.
- Archaeological scouting- detailed scouting is completed by a qualified archaeologist to identify any artefacts (such as spear tips, axes, stone workings etc.), scar trees or potential heritage features at the proposed sites. This is undertaken in addition to the NLC Traditional Owner clearances.

• Constructability assessment- Constructability constraints are identified including geotechnical assessments, cut/fill requirements, soil types, rig operational requirements (orientation) and access construction constraints (such as access track design, water course crossings etc.). This often includes preliminary pegging of the proposed

location

Once the location of infrastructure has been proposed and finalised, the final location is pegged and surveyed. The engineering designs are updated and issued for construction.

Civil construction

Once a site has been selected, the next step in the exploration well process is construction of access roads and water bores (groundwater monitoring and extraction bores) are typically the first construction activity. The proposed access tracks will be constructed to connect the Carpentaria Highway to the proposed lease pad and gravel pits, with the highway intersection upgraded in accordance with the Department of Infrastructure and Planning (DIPL) requirements. A small ~20 person temporary camp will be mobilised to site to support civil construction activities, with the temporary camp located on the camp pad or another cleared area in the vicinity of the planned infrastructure. The temporary camp will be a self-sufficient unit consisting of a kitchen, mess, offices, accommodation, gym, storage areas, power generation, fuel storage, NTG compliant sewage treatment system and treated effluent irrigation area.

Access tracks will be typically constructed (or upgraded) up to a width of 14m to allow 2-way traffic flow in accordance with the NT Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2. In some sections the width of access track disturbance may extend beyond the nominated width to accommodate cut out drains, culverts and truck turn outs etc. Access tracks will be typically sheeted with gravel to accommodate anticipated traffic volume. To minimise land clearing and disturbance, existing pastoral tracks or disturbed areas (such as historic seismic lines) will be utilised (and upgraded to the required specification as appropriate) where possible.

Once the initial access tracks have been cleared and formed, a water bore drilling rig will be mobilised to site. Two sets of groundwater monitoring bores (up to 6 bores in total) will be located within the disturbance footprint of the proposed large exploration well lease pad. The groundwater monitoring bores are required to be drilled on each exploration lease 6 months before stimulation activities, in accordance with the Code of Practice. In some cases, the second set of groundwater monitoring bores (referred to as impact monitoring bores) may be installed upon completion of the drilling of the exploration well. All groundwater monitoring bores are required to be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia.

Groundwater monitoring bores are required to be installed in all the regional aquifers (where present and saturated), which include the Undifferentiated Cretaceous sediments, Anthony Lagoon Formation and Gum Ridge Formation. These groundwater bores are used to monitor groundwater quality and level before and after stimulation, to detect any changes in groundwater parameters due to stimulation activities. These bores are also utilised to provide water to support for civil construction, well drilling, hydraulic fracturing and ongoing operations. Water may also be taken from pastoral bores, with formal permission from the pastoralist. All water take is required to be licenced under the NT *Water Act 1992*, with a Water Extraction Licence to be obtained covering all proposed take.

Once access tracks and water bores have been constructed, the lease pad, camp pad, helipad and laydown yard will be constructed. Construction typically involves the clearing of vegetation, grubbing to remove vegetation roots, stripping of topsoil (to maintain viability), levelling, sheeting with gravel and then compacting to achieve the working surface to support exploration infrastructure. Topsoil and felled vegetation will be stored around the edge of infrastructure, which will be used an erosion and sediment control measure. Additional erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains).

The lease pad will be constructed with additional infrastructure to support ongoing operations. This includes:

- A sediment retention pond will be installed to manage surface water within the lease, with water captured onsite tested and released into the adjacent area.
- A lined drilling sump to contain all drilling fluid, drilling muds, cuttings, cement returns and waste sand. The drilling sump will generally be able to contain up to approximately 3000m3 of material (approximately 75m long x 25m wide x 4.5m deep), with the final capacity determined by the proposed drilling depth and horizontal length.
- A flare pit used to combust all encountered liquid hydrocarbons in purpose designed flares (a flare pit may not be required where liquid hydrocarbons are not anticipated)
- three x 8m^3 concrete lined well cellars to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are transported to the site in one (1) piece and lowered into an excavated pit. A shallow conductor casing is installed within the cellar to approximately 20m

using an auger. The shallow conductor casing is designed to prevent the upper sections of the exploration well from caving in when drilling through the unconsolidated sediments. The cellar itself will be fenced at all times to exclude fauna ingress. Cellars will be typically separated from each other by 10m-20m

- An earthen bund consisting of topsoil/ subsoils used to prevent offsite release of wastewater during wastewater storage onsite.
- A fence and firebreak around the entire exploration site

Figure 4 Overview of an exploration site within the Beetaloo undergoing lease and camp pad construction, with water bore drilling underway.

Gravel will be extracted to support infrastructure construction from a new 5 hectare gravel pit that will be located with the Aboriginal Area Protection Authority (AAPA) cleared area. An additional geotechnical investigation will be undertaken to confirm the most suitable gravel pit location, to ensure the amount of clearing and land disturbance is minimised. The typical configuration of a gravel pit is provided in Figure 5, with the final location of the gravel pit to be confirmed with the pastoralist prior to construction.

Gravel pits will typically have two access points (one in and one out). Topsoils and subsoils will be stripped, segregated and used to form an earther berm around the site to prevent overland flow from entering or exiting the pit. Felled vegetation will be placed on the outer berm of the pit to increase stability. Where the pit void represents a hazard to cattle, the gravel pit will be fenced when not in operation.

Figure 5 Picture of a typical working gravel pit located within the Beetaloo

Seismic Survey

Subsurface seismic imaging will be completed around lease pad. The seismic program involves the acquisition of up to 200km^2 of 2D or 3D seismic to develop localised geological knowledge of the underlying formations. It is anticipated that the seismic program will be executed over a number of years, typically with approximately 40km^2 of surveys being completed during each campaign.

The aim of a seismic survey is to produce detailed images of the various rock types and their location beneath the earth's surface. This information is used to determine the location and size of oil and gas reservoirs. The seismic method uses a sound wave source either dynamite (Figure 6) or Vibroseis trucks (Figure 7) to propagate sound waves into the earth. The sound waves that reflect off underground rock formations are captured by recording sensors called geophones (Figure 8). Analysing the time sound waves take to return provides valuable information about rock types and an estimate of depth for rock formations. The returning reflections are recorded in a digital format and sent to a seismic data processing centre to produce a cross-section image of the layers of the earth’s crust (process seismic image).

Figure 6 Examples of small rigs that could be used for drilling source holes for a dynamite survey

Figure 7 Example of Loaded charge in hole ready for detonation and example of a charge used in dynamite seismic survey acquisition. Change length is approx. 400-500mm in length

Figure 7 Example of a vibrioses utilised during seismic acquisition (noting a vibroseis is not used if dynamite is the selected energy source)

Figure 8 Left: Example of geophone used for 3D Seismic and Microseismic, Right: Example of geophone deployment for both 3D Seismic and Microseismic.

The use of small dynamite charges is an environmental friendly approach that minimises the requirement to clear seismic lines. Small charges are placed at regular intervals along a line either by hand or utilising a track based ATV or similar. This approach reduces the need to clear vegetation, with the charges being able to be placed around vegetation to reduce clearing. Small amount of clearing may still be required to access extremely dense vegetation, but this is anticipated to be minimal. An image of a typical small seismic charge used during a New Zealand seismic shoot is provided in **Figure *6***

If Vibroseis trucks are selected for the seismic source then line clearing may be required so that the Vibroseis trucks can drive and operate over the survey area. Where possible, existing cleared areas will be utilised to reduce disturbance. . Seismic lines will be selected in a manner to avoid any large habitat trees or sensitive flora, with no material clearance to be undertaken in watercourses and associated riparian vegetation. In areas with low vegetation density (such as open Eucalypt / Corymbia woodland) ground disturbance will be restricted to the removal of rocks and fallen branches and the

slashing of grasses and shrubs to provide effective ground contact of the seismic vibro-source and the geophones and minimise the risk of fire. An example of low impact clearing is provided in Figure *12*. Where ground clearance is unavoidable, such disturbance will be undertaken with a grader and the access width shall be no more than 1 blade width wide (4m) with minimal ground disturbance sufficient to provide for safe vehicle access. Some patches of lancewood (Acacia shirleyi) and Bullwaddy (Macropteranthes kekwickii) are present along the proposed seismic lines. These areas represent the thickest vegetation and will require clearing with a D6 dozer.

Figure 9 seismic line construction for vibroseis source acquisition

To reduce the risk of bushfire, no vegetation mulching is proposed. Felled vegetation will be pushed to the side of the seismic line during operations. The felled vegetation will be returned across the seismic line upon completion of seismic activities to aid in rehabilitation and assist in erosion and sediment control. Root stocks are to be left in place as much as practicable to allow for rapid re-establishment of vegetation. Based on previous experience in the region, most areas will naturally regenerate following rehabilitation following the wet season. Rehabilitation monitoring will occur on an annual basis until the vegetation has become re-instated, with maintenance on rehabilitated area undertaken as required.

Surveying commences shortly after line preparation. The field surveyors use real time kinematic GPS receivers to position receiver points for the surveys. Surveyors mark the ground with biodegradable paint, or points are marked by wooden stakes. Line detours may also be marked with temporary biodegradable flagging.

Each survey team consists of one surveyor in a light 4WD vehicle or ATV, and generally makes only one pass over any given section of line. Back tracking may occur in areas where vehicle access routes have deviated from the true line position and markers must be inserted by personnel on foot. This may occur in areas of riparian vegetation if there is adequate access either side of the watercourse.

Recording normally commences two to three weeks after the start of line preparation. This operation is the largest part of the seismic operation in terms of personnel and vehicles. The size of the crew will vary depending on the recording technique used, terrain and season and recording is generally restricted to daylight hours.

Work commences with the deployment of nodal geophones supported by light 4WD vehicles or ATVs. The nodal geophones are autonomous units, containing the actual geophone as well as battery and data storage in one unit. These nodes are deployed at regular intervals along the non-cleared lines perpendicular to the source lines, these may be able to be carried through areas of riparian vegetation to avoid any damage to vegetation where access permits.

Recording will commence once the survey areas has been laid out with geophones. This layout is termed ‘the spread’ and picks up the acoustic energy reflected from subsurface layers. If Dynamite is the energy

source, then the shots will be let off in sequence and recorded by all the geophones. If Vibroseis is the energy source then the truck(s) drive along source lines vibrating the ground at a set intervals with the energy is recorded by all the geophones.

After the energy source is finished the geophones are collected, rehabilitation and data analysis can commence.

Microseismic Monitoring

Microseismic Surveys are undertaken to monitor 'listen to' the Hydraulic Fracture Stimulation Operations. Microseismic can assist Origin in analysing the performance of the Stimulation.

During stimulation water and sand are injected by high pressure into the reservoir rock creating small fractures. As these small fracture initiate (crack) and propagate (further cracking) away for the well bore they generate pressure waves (seismic energy) that can be measured on the surface with extremely sensitive sensors. These sensors called Geophones or Seismic Receivers are individual weatherproof units that contain a sensitive seismic recording device, memory storage, a long-life battery and GPS locator. The sensors are cylindrical and 4cm wide and 13cm tall.

The Geophones are deployed 10-20 metres apart along line over an area of 30-40km2 around the well. Geophone deployment locations are located on foot by GPS locator. A handheld battery drill is used to create a 4cm diameter hole with an auger bit, a small quantity of water may be used to stabilise the soil. The Geophone is inserted into the hole so that the top of the receiver is flush with the surface of the ground (Figure 8).

The Geophones deployed prior to the commencement of stimulation and retrieved after the stimulation has concluded.

The Geophones are retrieved by creating a small divot next to the Geophone and the Geophone is pushed into the divot and then pulled out of the ground. Stubborn geophones may need to be dug out with a small trowel, small holes and divots are filled in with any disturbed soil.

Deployment and Retrieval of the Geophones is undertaken in small teams of 2 or 3 people, with the number of deployment teams depending on survey size. The teams are supported by a light 4WD vehicle or an All-Terrain Vehicle to carry equipment, gear, water, communication (radio/satellite phone), first aid kits and safety gear.

No line clearing or heavy machinery is required, and the activity is considered to have a minimal impact, similar to that of scouting activities.

Camp construction and operation

Once all the access tracks and civils work is completed, a temporary camp and drilling package would be brought in to undertake the drilling activity. An image of a commissioned drilling rig and associated infrastructure is provided in Figure 10**Error! Reference source not found.**.

The temporary camp will typically be the first infrastructure mobilised to site to support operations. The camp will be a self-contained facility with accommodation rooms, kitchen, dining mess, offices, ablutions, gymnasium, storerooms, refrigeration, water storage, power generation, solid waste management, fuel storage, water treatment, sewage treatment and sewage irrigation area. The camp will typically accommodate approximately 50 to 100 people at a time.

Potable water for the camp will either be trucked to site or generated onsite with a purpose designed water treatment unit. All grey and black water will be treated using an NTG compliant sewage treatment system, with treated effluent irrigated in a spray field adjacent to the camp.

Exploration well drilling

A drilling rig package consists of the main rig package as well as supporting vehicles and pieces of equipment. Generally, the following equipment would be on site during the drilling operation:

- The main drilling rig package consisting of a rig floor, a mast or derrick, and the rig diesel engine.
- Racks for storing drill pipe or casing and potentially a "pipe arm", which is a piece of equipment designed to bring pipe and casing up to the drill floor.
- The rig's drilling fluid system including tanks and pipes for storing and pumping fluid down the drill string.

- A smaller rig camp (~8 people) and ablutions block to accommodate critical drill staff required to be onsite during night-time operations.
- An air drilling system consisting of piping and air compressors for directing compressed air down the drill string may also be used.
- Storage trailers and racks for equipment such as mud chemicals, drill pipe, casing, and other equipment used down hole to complete the operation.
- Freshwater storage tanks (typically 1.9ML -3.5ML)
- A work/welding shop.
- Portable onsite offices.
- Ablution block, wastewater treatment plan and effluence irrigation area.
- Chemical storage areas
- Power generators
- Bulk diesel storage areas
- Third party equipment such as cementing trucks, coil tube unit and wireline evaluation units would also be required on site intermittently as per operational requirements.

Trucks delivering equipment and consumables (e.g. drilling consumables, fuel, food and water) would be travelling to and from the site regularly. There would also be regular light vehicle activity to transfer people between the drilling rig and camp.

Once the drilling rig is rigged up, tested, and functional, the drilling of the vertical section of the exploration well will commence. An overview of a drilling rig is provided in Figure 10. A large diameter drill string (also known as the bottom hole assembly or “BHA”) would be used to drill a ~15-25” hole to a depth shallower than the Anthony Lagoon formation (if present and saturated). This section would be drilled with fresh water and “sweeps” (intermittent volumes) of higher viscosity fluid to help remove cuttings out of the hole. A large diameter string of casing (referred to as a conductor casing) would then be set and cemented at this depth.

Figure 10 Typical well site layout during drilling. This site is the existing Kyalla 117 N2 site.

The drilling rig would then be set up to drill through the Gum Ridge Formation into the Antrim Plateau Volcanics (assuming they are present). At this point a further string of casing (referred to the surface casing) would be run and cemented to seal the aquifer off from the rest of the wellbore. A blow out

preventer (BOP) would be installed on top of the string of casing and pressure tested. A successful pressure test would ensure the BOP is functioning correctly and confirm the integrity of the casing and cement.

Drilling will then recommence and a few metres into the underlying formation. A test known as a “leak off” test would then be conducted to understand the rock strength; this involves applying just enough pressure to the fluid in the hole to break the formation. The information gained during this test is critical for maintaining the integrity of the hole as it indicates how much pressure can be safely applied to the formation, and also the maximum mud-weight that can be used to provide well control. Following a successful test, drilling will proceed to a depth selected by geologists, reservoir engineers and drilling engineers based on subsurface understanding and well objectives. A further string of casing (the intermediate casing) will then be installed and cemented to seal off previous formations, and if so, the casing shoe would then be drilled out and another leak off test conducted.

The final hole section (referred to as the “production hole section”) covers the primary hydrocarbon reservoir section(s) and is drilled to the well total depth (TD). TD is likely to be less than 4000m below the ground surface, with the final depth dependent on the target formation and its encountered prospectively. Drilling activities could also include coring, a process in which a drill bit with a cylindrical opening is used to cut-out rock cores for geological, geochemical and geomechanical studies.

Once TD is reached, the BHA is pulled out of the hole and the well cleaned by means of circulation. Following wellbore conditioning, a series of special tools are run down and up the hole to measure various aspects of the reservoir fluids and rocks. This process is known as wireline logging. Wireline logging activities may also include sidewall coring, a process that allows small cores/rock samples to be cut from the side of the hole using wireline tools.

Diagnostic Fracture Injection Tests (DFIT) may be run to further investigate rock properties. The DFIT has become the primary safety and transient test for ultra-low permeability shales. It involves injecting small volumes of water at low rates to create small fractures, allowing the resulting pressure to fall naturally. The fluid contains no proppant hence the fracture relaxes and closes naturally when pressure is released. The pressure decay is monitored onsite and the data acquired is analysed to aid in reservoir characterisation. The DFIT can be carried out while the rig is on site or after the rig has been mobilized.

If the well is to have a horizontal section, the well will be deviated above the production reservoir. The production hole section is drilled with the help of steering tools, which are used to gradually build the inclination so the well penetrates the prospective reservoir zone with a horizontal alignment usually for a total length of 1000-3000 m. In addition, logging while drilling (LWD) tools may be employed to enable measurement of rock properties such as the natural radiation signature or resistivity of the rocks, in order to facilitate identifying key changes in rock type down the wellbore. The horizontal well is typically cased and cemented, awaiting hydraulic fracture stimulation.

During drilling, a KCl/NaCl/Polymer or Synthetic based fluid system is likely to be the base fluid for drilling. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the bit, and lift drill cuttings to surface. A KCl/Polymer fluid system consists of water with salt (to prevent formation swelling) and a viscosifying agent (usually the naturally occurring mineral bentonite or a starch similar to those used in food manufacturing (i.e. guar gum)).

Waste drilling muds, cuttings and fluids produced during drilling are directed to the drilling sump for ongoing storage and management. Drilling waste (muds, cuttings and fluids) will remain in the sump until all drilling activities have been completed. The drilling wastes will then be evaporated with all residual fluid removed from site to an offsite disposal facility prior to final sump rehabilitation. The drilling wastes will be sampled and a risk assessment completed to determine the suitability for onsite mix-bury-cover or encapsulation. Where the drilling waste material cannot be disposed of on the site safely, the drilling waste will be removed to a third party facility and the sump backfilled.

Hydraulic Fracture Stimulation

Upon completion of drilling, activities, a frack spread will be mobilised to site to commence hydraulic fracture stimulation (HFS or stimulation) activities. A frack spread consists of:

- Data Van – on-site office to execute stimulation activities
- Water Storage - tanks will be constructed on-site, capable of managing both make-up water and flowback water. Tanks will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner
- Proppant Trailer - a large sand storage and delivery trailer that holds the proppant

- Hydration Unit – used to add stimulation additives and viscosifying fluids • Blender Unit – used to mix proppant and fluid additives, prior to its injection into the well
- High Pressure Pumps – pumps which inject the hydraulic fracturing fluid mixtures from the Blender Unit down the well, via the surface lines and hydraulic fracturing wellhead or coiled tubing unit
- Coiled Tubing Unit – a large length of coiled steel pipe that can be temporarily installed in the well to perform various downhole operations • Wireline unit – plug and perforation deployment
- Ancillary support buildings – offices, workshop, cranes, chemical storage area, equipment storage, power generation and all other activities required to support stimulation activities.

Stimulation involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore approximately 1000m – 4000m below ground level (depending on the depth of the target formation). Typically, 92-96% or higher of the total volume in stimulation fluids is a combination of fresh water and sand, with the remainder as fluid-conditioning additives (~2-4-%).

Prior to the commencement of stimulation activities, the integrity of the well is tested with a cement bond log and pressure casing test. This integrity report is submitted to the regulator prior to the commencement of stimulation activities. Once the integrity of the well is confirmed, stimulation activities will commence. The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to the discrete target intervals along the horizontal wellbore (referred to as 'stages'). Each stage will be isolated and perforated using a plug and perforation gun assembly deployed via a wireline unit. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in-situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities.

During each stimulation wellbore pressures are monitored to ensure the operations have not compromised the integrity of the production casing or the cement barriers. A Maximum Allowable Operating Pressure (MAOP) is an important engineering parameter used to define the operating envelope (i.e. the safe maximum pressure that should not be exceeded). The maximum allowable pumping pressure (MAPP) is set below the MAOP to allow for uncertainty and provide an additional safety margin so the MAOP is not exceeded. In addition, continuous groundwater level monitoring and ongoing field testing is completed on the control and impact groundwater monitoring bores to detect any changes in groundwater characteristics that could be associated with stimulation activities.

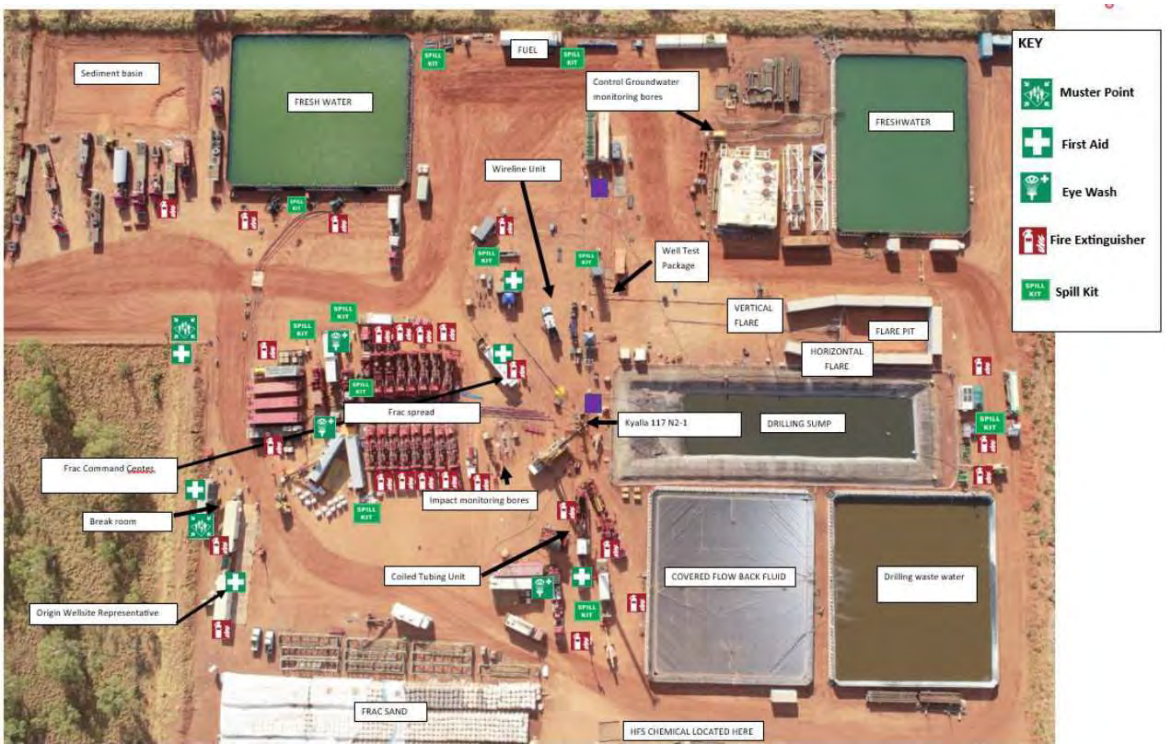


Figure 11 Typical Hydraulic fracture stimulation spread at the Kyalla 117 N2 site.

Extended Production Testing

After the completion of HFS operations, the well will be initially flowed back for several days to remove any residual sand and sediment from the well. The well with then be “completed”, with a completion rig or coil tubing unit mobilised to site to install production tubing, downhole gauges, artificial lift etc within the well. Once completed, the well will be brought online and a production test completed to measure the volumes of water and gas flow produced from the reservoir to assess the technical and commercial potential of the resource. In some cases, a nitrogen lift may be completed using a coil tubing unit to initiate early production until the well can sustain itself.

Production tests may typically range from 1 month to 24 months, depending on operational requirements. During a production test, hydrocarbons (liquids and gaseous) and water (flowback) are measured and separated onsite in a separator. Produced gas will either be flared onsite or beneficial utilised in onsite power generation. Condensate will be stored within condensate storage tank for offset trucking or sent to the flare for combustion. Flowback is directed into purpose built enclosed and open wastewater tanks where it will be stored and evaporated onsite (“treated”) until offsite disposal. To assist in managing flowback volumes across the basin, flowback may be moved to and from the site to maximise the use of water management infrastructure in the region.

Figure 12 Example of a well test underway at an exploration site in the Beetaloo Basin.

Well suspension and decommissioning

Once all well testing operations are completed a decision is made to either safely suspend the well (e.g. for further testing or evaluation work in the future) or to plug and decommission the well. If the well is suspended, all suspension operations and procedures are conducted in accordance with regulatory requirements and industry best practise. This includes periodic exploration well intervention and maintenance, surface well head maintenance, surface infrastructure maintenance, performing routine site inspections and ongoing environmental monitoring (groundwater, weeds, erosion and methane leaks).

The plug and decommissioning process includes setting cement plugs in the hole to isolate permeable zones and prevent cross flow between different rock layers exposed by the drilling process. A cement plug would also be set across the open hole section and previous casing and pressure tested to ensure it acts as an effective fluid barrier to surface. Another plug would be set inside the casing prior to removing the BOP and cutting the casing off at surface. Finally, cement would be poured into the casing stump at surface and a plaque installed to identify the decommissioned well.

Once the well has been fully decommissioned, all associated temporary equipment would be then removed from the site. All disturbed areas (e.g. lease pad, gravel pits, camp pads etc.) will then be rehabilitated and re-vegetated back to a safe, stable, non-polluting landform that is consistent with the surrounding landscape. The only infrastructure that would be kept includes water bores (potentially for monitoring and / or for pastoralist's use) and any roads required to access them.

A detailed description of the activities, their timing and typical duration is provided in Table 2. Pictures of selected activities have also been provided to assist in understanding the size and nature of the activities. It should be noted that these pictures are indicative and activities may differ based on the site specific constraints, final design and operational requirements. Additional information on each of the activities can be provided upon request.

Table 1 Description of proposed regulated activity details withc each of the clearance areas

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Access track construction Access tracks will be constructed to connect up the proposed infrastructure to existing roads. Tracks will be constructed in accordance with NT Standard Drawings (CS3003) for Typical Cross Section for Rural Environment – Pastoral Access Road 2. The access track will align with the existing seismic line disturbance to minimise vegetation clearing. The access track will typically be less than 14m wide, with sections up to 20m wide where truck turn outs, erosion and sediment control and cut out drains are required. Gravel will be used to form up the access track in places to enable all weather access. Where access tracks intersect with main roads (such as the Carpentaria highway), the intersection will be upgraded to accommodate turning truck traffic in accordance with the department of Infrastructure, Planning and Logistic (DIPL) design requirements Access tracks are anticipated to be the first piece of infrastructure constructed to enable preliminary activities, such as the construction of groundwater monitoring bores.	<50ha (dependent on access track length)	<12 people	Fist activity required to enable civil construction and drilling.	Access tracks are likely to be continually maintained and surfaced throughout the life of the activity	
Seismic consists of the following: 200km^2 of seismic acquisition will be undertaken. **Dynamite charges- minimal disturbance approach** It is anticipated that the survey will be collected using dynamite, to minimise the clearing of vegetation. In such a case, vegetation clearing will be restricted to extremely dense vegetation where site access is prevented. The charges are approximately 1kg and will be installed within a 200m grid pattern, to a depth of approximately 10-15m underground. The charges will be installed using a small ATV/ 4wd mounted auger (refer Figure 6). The charges are packed into place and detonated in a controlled fashion with appropriate exclusion zones. The created detonation zone is kept underground, with no surface disturbance anticipated. The detonated charge create a “thud sound” which can be heard within 2-4km radius and felt within a 200m radius (typically)	10ha to 500ha	Up to 35	Before or after exploration well drilling with the final time to be finalised.	3 – 6 weeks per campaign	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
vibroseis (if utilised) If the seismic energy source is Vibroseis truck(s) then line clearing will be required so that they drive and operate over the survey area. wide Source lines, for Vibroseis trucks to operate on, will need to be cleared4km every 200m. Existing cleared areas will be utilised where possible to reduce disturbance. The line tolerances for weaving around vegetation are allowed. Seismic lines will also be in a manner to avoid any large habitat trees or sensitive flora, with no clearance to be undertaken in watercourses and associated riparian vegetation. **Surveying:** Surveyors mark the ground with biodegradable paint, or points are marked by wooden stakes. Line detours may also be marked with temporary biodegradable flagging. A survey team in a light 4WD vehicle or ATV, will make generally one pass over any given section of line. **Recording:** Recording normally commences two to three weeks after the start of line preparation. This operation is the largest part of the seismic operation in terms of personnel and vehicles. The size of the crew will vary depending on the recording technique used, terrain and season and recording is generally restricted to daylight hours. Geophones are deployed at regular intervals along non cleared lines perpendicular to the source lines. If Dynamite is the energy source, then the shots will be let off in sequence and recorded by all the geophones. If Vibroseis is the energy source then the truck(s) drive along source lines vibrating the ground at set intervals with the energy is recorded by all the geophones. After the energy source is finished the geophones are collected rehabilitation and data analysis commence. **Rehabilitation:** Felled vegetation will be pushed to the side of the seismic line during operations. The felled vegetation will be returned across the seismic line upon completion of seismic activities to aid in rehabilitation and assist in erosion and sediment control. Root stocks are to be left in place as much as practicable to allow for rapid re-establishment of vegetation. Based on previous experience in the region, most areas will naturally regenerate following rehabilitation following the wet season.					 e.g. of rehabilitation efforts in progress (HESS, 2013). e.g. of recruitment of vegetation post rehabilitation of open *Eucalyptus* woodland (HESS, 2013).
Groundwater (monitoring and extraction) bore installation Installation of up to 3 control and 3 impact groundwater monitoring bores (6 in total) may be constructed on each of the lease pad within the underlying aquifers. These bores are required under the Code of Practice to establish baseline groundwater level and quality data prior to completing hydraulic fracture stimulation activities. Monitoring bores are required to be drilled at least 6 months prior to stimulation activities and are often the first activity undertaken on a site (other than access tracks). Monitoring will continue throughout thelife of the activity. The bores will also be used for groundwater extraction to support exploration activities. The construction of the groundwater monitoring bores will utilise a water bore drilling rig to construct the bores, identical to the rig used to drill pastoral water bores. All groundwater monitoring bores will be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia. Bores may drilled into the Anthony Lagoon formation (if present and saturated), Gum Ridge formation and potentially the Bukalara Sandstone. Waste cuttings, drilling fluids, muds and formation fluids will be collected in a smallearthen sump and managed in alignment with the practices outlined in the. Minimum Construction Requirements for Water Bores in Australia. The fluid (which is anticipated to be fresh) will	N/A located on proposed lease pad	<12 people	The drilling of water bores is generally one of the first activities undertaken to provide water for construction and drilling activities. Additional monitoring bores are also likely to be drilled prior to stimulation	<4 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
be discharged to grade and the area surrounding the lease. The formation cuttings and drill muds will be mixed with soil onsite and incorporated into the lease pad surface.					
Lease pad construction Each proposed lease pad will be constructed to approximately 7.5 hectares to accommodate exploration well drilling, stimulation, testing and ongoing wastewater storage and treatment. Each lease pad will be located within the proposed clearance area, with the final location based upon seismic information combined with cultural, environmental, pastoralist and regulatory constraints., . Once a suitable site has been selected the lease pad will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of the lease pad to form a bund, which will be used as both an erosion and sediment control measure and wastewater containment bund. The lease pad will then be levelled, compacted and surface with gravel to accommodate exploration activities. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains). A sediment retention pond will be installed to manage surface water within the lease. Water captured onsite will be tested and released into the adjacent area. A drilling sump, flare pit and well cellars will be constructed onsite. The drilling sump will be lined with an impermeable liner to contain all drilling fluid, drilling muds, cuttings, cement returns and waste sand. The drilling sump will generally be able to contain up to approximately 3000m^3 of material (approximately 75m long x 25m wide x 4.5m deep). The drilling sump/ broader site will be fenced to prevent livestock access. The well cellars will be constructed on the proposed lease to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are concrete lined and will be prefabricated off-site. The cellars are transported to the site in one (1) piece and lowered into an excavated pit. A shallow conductor casing is installed within the cellar to approximately 20m using an auger. The shallow conductor casing is designed to prevent the upper sections of the exploration well from caving in when drilling through the unconsolidated sediments. The cellar itself will be fenced at all times to exclude fauna ingress. Cellars will be typically separated from each other by 10m-20m..	7.5 ha	<24 people	Prior to exploration drilling	2-8 weeks	
Camp pad construction and camp operation A camp pad up to 1.2 ha will be constructed adjacent to each proposed lease pad to accommodate a temporary 70 man camp (typically less than 70 man) to support civil construction and exploration (drilling, stimulation, testing and decommissioning) activities. Smaller, mobile camps may also be utilised across the clearance area during operations where required 9for example to support seismic activities). The camp pad will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of the camp pad. The camp pad will then be levelled, compacted and surface with gravel to accommodate exploration activities. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains). Camps will be constructed with kitchens, offices, ablution blocks, accommodation blocks, storage containers, gymnasium, refrigeration, water treatment plan, sewage treatment plant, waste management areas, water storages, power generation, diesel storage tanks and car parking.	1.2ha	<60 people (including housed staff)	For duration of activity	For duration of activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
All waste will be covered/ stored in a manner that prevents feral animal access. An approved wastewater (sewage) treatment plant will be utilised to treat all sewage, with treated effluence irrigated in a fenced area adjacent to the camp (no clearing required). Treated effluence treatment and irrigation will occur in accordance with the NT Department of Health requirements.					
Helipad pad construction and operation A 1ha helipad may be constructed to accommodate wet season operations adjacent to each lease pad. Where prolonged access to the site is restricted, personnel and material will be helicoptered to and from site. The helicopter pad will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of helipad. The helipad will then be levelled, compacted, surface with gravel and then fenced. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains).	1ha	N/A	For duration of activity	For duration of activity	
Laydown/storage yard construction and operation Laydown/ storage yard may be constructed along access track to each of the proposed sites to store materials, wastes, water tanks, equipment and other material as required. The laydown yard will be fenced to prevent access. These are typically 2.5 hectares in size. The laydown/ storage yard will be cleared of vegetation, grubbed and stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of helipad. The yard will then be levelled, compacted, surface with gravel and then fenced. Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, woah boys and diversion drains).	2.5ha	N/A	During exploration activities (as required)	For duration of activity	
Gravel pit construction and operation. Up to 15 hectares of gravel pits (multiple pits, anticipated to be ~5) will be constructed to support the construction of infrastructure onsite. The exact location of pits within the clearance area will be determined based on operational requirements (i.e. pits are constructed as close as needed to infrastructure) and through further testing Each gravel pit area will be progressively cleared of vegetation in 1-2 hectare stages (to minimise the required disturbance). Each pit stage will be stripped of topsoil down to approximately 100mm (depending on the depth of topsoil onsite). Topsoil will be stored around the edge of the lease pad to form a bund, which will be used as both an erosion and sediment control measure and to prevent overland flow access to the site. Subsoils will also be stripped, segregated from topsoil and stockpile around the edges of the gravel pit. Gravel will be periodically extracted from the pit, with the pit designed to drain internally. The Erosion and sediment controls will be constructed around the disturbed areas (such as rock check drains, diversion drains and bank stabilisation using fallen debris).	Gravel pit <15ha	<6 people	For duration of activity	For duration of activity	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Once gravel activities are finished, the pit will be reshaped, with subsoils re-instated. Topsoils will be spread and fallen vegetation returned to aid site stability. The area will be temporarily fenced (where required) to allow vegetation regrowth. Seed maybe added to the site to support natural regeneration if required. The pits may be converted to pastoral watering points where appropriate and approved by pastoralists. An access track will be constructed to each pit, with the length of access track to be determined based on location of the pit The access track will typically be less than 14m wide, with sections up to 20m wide where truck turn outs, erosion and sediment control and cut out drains are required.					
Exploration well drilling Up to 8 petroleum exploration wells are proposed to be drilled at each site. Wells may be drilled in stages (i.e. 1 or 2 at a time) or progressively (i.e. 8 wells drilled over 5 years)Each well will be drilled into an underlying prospective petroleum reservoir (each as the Velkerri shale, Kyalla shale or other formation) to a typical maximum depth of 4000m. Each well will be deviated into the horizontal position, with a lateral drilled up to 3000m (please note the depth and lateral length may change based on operational require. ments). Each petroleum well is designed and constructed in accordance with the Code of Practice for Onshore Petroleum Activities within the Northern Territory (Code of Practice) to maintain well integrity and protect aquifers and the environment. A Well operations management plan (WOMP) is required to be submitted to the regulator and approved prior to the drilling of any wells. The WOMP outlines the well design and drilling practices that will be deployed to ensure compliance with the Code of Practice and protect underlying aquifers and the environment. Each well is anticipated to be constructed with multiple casing and cement strings, typically 5- consisting of a shallow conductor casing, deeper conductor casing, surface casing, intermediate casing and production casing. Once the well design is approved by the Northern Territory government (NTG), a rig package will be mobilised to site, which consists of a drilling rig (comprising rig matting, a rig floor, mast or derrick, rig engine, blow out preventor, catwalk, safety flare etc.), pipe racks, casing strings, drilling rods, rig fluid system (mud tanks, shakers, mud treatment system and pipework) storage trailers, bunded chemical storage areas, workshop portable onsite offices, crib huts, mini-rig camp and sewage treatment system and irrigation area), freshwater storage tanks, diesel power generation, cement trucks, bulk fuel storage, water transfer pumps, fork lifts, lighting towers, crane etc. The rig will be constructed over the pre-installed conductor casing and cellar. Once functional, drilling will proceed down below the first encountered aquifer, where the first casing section of the well will be installed (either in the Anthony Lagoon Formation if present and saturated or the Gum Ridge formation (anticipated to be present). A BOP will then be installed, to ensure any influxes of gas, water or pressure are able to be safely managed during drilling of the remaining sections of the well. The drilling rig will continue to drill the various other casing and cement sections. The integrity of each of these casing strings is tested through a combination of leak off tests, casing pressure tests, cement return tracking and cement bond logs. Upon completion of drilling, a barrier integrity verification report is submitted to the regulator summarising the integrity of the well. This report is publicly available. Once each well is finished drilling, the well head is installed and the rig is either “walked” to the next adjacent location with the process repeated or mobilised to a new location. A low toxicity water-based drilling mud is to be used as the base fluid for drilling, which primarily contain salts and polymers. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the drill bit and lift	N/A located on proposed lease pad	<60 people	Pastoralist to be notified when drilling proposed	Typically 60- 90 days per well	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
cuttings to the surface. The fluid system consists of water with a sodium or potassium-based salt (to prevent formation swelling) and a viscosifying agent such as bentonite. Other low toxicity chemicals such as barite, citric acid, sodium bicarbonate and loss circulation material (fibres such as coconut coir or nut hulls etc.) may also be used. The chemicals used for drilling are consistent with those used for water bore drilling. Waste drilling muds, fluids, cuttings and mineral waste (such as cement returns, sand etc.) brought to surface will be stored in the lined drilling sump. Drilling fluids will be evaporated and then removed from the sump and disposed of offsite. Solid waste within the drilling sump will be allowed to dry out and then either removed from site or disposed of onsite in accordance with the Code of Practice. Where onsite disposal is proposed, a risk assessment will be completed demonstrating that the activity can occur with no residual environmental harm. Onsite disposal can include encapsulation or mix bury cover, depending on the site specific details and final composition of the drilling waste material. Subsurface diagnostic tools will be run on the well during and after drilling to understand the nature of the target reservoir. Some sections of the formation may be cored or have sidewall samples collected, which will add further analysis of the reservoir properties. To assist with determining the suitability and capacity of these formations for potential gas extraction activities, diagnostic fracture injection test (DFIT) may be conducted across a number of shale intervals to evaluate the geo-mechanical and reservoir properties of the targeted formation. Prior to a DFIT, a cement bond log and casing pressure test is completed to ensure the integrity of the cement and steel casing. A DFIT involves the injecting of small volumes of a water (approximately 30 barrels (5,000L) per DFIT) at low pumping rates to create a small fracture in the target interval. The well is shut-in, and the pressure allowed to fall-off naturally. Monitoring the fall-off pressure over time allows information to be derived about the reservoir. The fluid does not contain proppant so that the fracture closes naturally when the fluid leaks off into formation. The analysis of pressure, during injection and after shut-in, provide powerful tools for understanding and subsequently informing the design for a future hydraulic fracturing process (not in this scope). Any returned fluid will be stored within double lined tanks and disposed of offsite at a licenced facility. All waste drilling fluids, muds, cuttings, DFIT return fluid and cement returns will be managed in the existing lined drilling sump on-site. Once drilling has been completed, this material will be sampled as per the code of practice and a detailed risk assessment completed to determine whether onsite encapsulation or mix bury cover can occur in ana environmental acceptable manner. In most cases, drilling wastes will be dewatered, blended with native soil and encapsulated within an impermeable liner. A cap of clean material will be placed over the liner to enable vegetation growth.					
Hydraulic Fracture Stimulation Upon completion of drilling activities, a frack spread will be mobilised to site to commence hydraulic fracture stimulation (HFS or stimulation) activities on each of the drilled wells. A frack spread consists of: • Data Van – on-site office to execute stimulation activities • Water Storage - tanks will be constructed on-site, capable of managing both make-up water and flowback water. Tanks will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner • Proppant Trailer - a large sand storage and delivery trailer that holds the proppant • Hydration Unit – used to add stimulation additives and viscosifying fluids • Blender Unit – used to mix proppant and fluid additives, prior to its injection into the well • High Pressure Pumps – pumps which inject the hydraulic fracturing fluid mixtures from the Blender Unit down the well, via the surface lines and hydraulic fracturing wellhead or coiled tubing unit • Coiled Tubing Unit – a large length of coiled steel pipe that can be temporarily	N/A located on proposed lease pad	<50 people	Post exploration well drilling	2- 8 weeks per well depending on stimulation size	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
installed in the well to perform various downhole operations • Wireline unit – plug and perforation deployment • Ancillary support buildings – offices, workshop, cranes, chemical storage area, equipment storage, power generation and all other activities required to support stimulation activities. Stimulation involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore approximately 1000m – 4000m below ground level (depending on the depth of the target formation). Typically, 90% or higher of the total volume in stimulation fluids is a combination of fresh water and sand (~6-8%), with the remainder as fluid- conditioning additives (~2-4-%). Prior to the commencement of stimulation activities, the integrity of the well is tested with a cement bond log and pressure casing test. This integrity report is submitted to the regulator prior to the commencement of stimulation activities. The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to the discrete target intervals along the horizontal wellbore (referred to as 'stages'). Each stage will be isolated and perforated using a plug and perforation gun assembly deployed via a wireline unit. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in-situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities. Wellbore pressures are monitored during each stimulation, to ensure the operations have not compromised the integrity of the production casing or the cement barriers. A Maximum Allowable Operating Pressure (MAOP) is an important engineering parameter used to define the operating envelope (i.e. the safe maximum pressure that should not be exceeded). The maximum allowable pumping pressure (MAPP) is set below the MAOP to allow for uncertainty and provide an additional safety margin so the MAOP is not exceeded.					
Exploration well completion Once each well has been stimulated, a completion rig will be mobilised to site to "complete" the well. This involves installing downhole equipment such as packers, plugs, production tubing, artificial lift etc. required to enable the production testing.	N/A located on proposed lease pad	<12 people	Post stimulation	1-2 weeks	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Well testing Once the well has been completed, the well will be brought online and tested. To enable the testing, a well test package will be installed at the site consisting of: • Separators (to separate gas, condensate and water) • Flares (either a vertical or horizontal), • Flare pit (if a horizontal flare is utilised • surface pipework, manifolds, and tanks • communication and generator shacks • workshops/ storerooms • bulk diesel tanks • wastewater storage tanks (converted freshwater storage tanks used for stimulation makeup water) • Water transfer equipment • Wastewater evaporation and treatment units • Camp accommodation. The exploration well will be underbalanced (or "unloaded") to initiate production, either through its own energy or through artificial lift (such as through a Nitrogen lift or pump). The fluid and gas will be sent through a separator, with all hydrocarbon metered and flared. Flowback water will be discharged from the separator into designated wastewater storage tanks. Well testing will typically be undertaken form a period of 1- 24 months- depending on the objective of the well. Multiple well testing operations may be required to test the behaviour of the formation to determine whether extended shut ins can affect well productivity. Gas will be used beneficially onsite to reduce greenhouse gas emissions where possible. This includes the use in power generation for hosting data servers, digital miners or other beneficial activities.	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	Typically 30 days to 24 months.	
Wastewater tank storage Flowback wastewater will be treated on site via evaporation (or other treatment technologies such as enhanced evaporation units, brine crystallisation etc.) and removed from site upon completion of activities. Double lined wastewater tanks will be utilised to store wastewater, with the volume and number of tanks installed dependent on the anticipated flowback return volume. Wastewater storage tanks have continuous level monitoring, with leak detection sensors located within the interstitial space between the primary and secondary liners. It is anticipated that between 10ML to 30ML of tanks storage may be installed onsite, with a combination of enclosed tanks and open treatment tanks. In accordance with the Code of Practice, sufficient enclosed tank capacity must be onsite to store all wastewater. Flowback can only be stored within open tanks where undergoing treatment (such as evaporation). Open evaporation tanks must have a 1:1000 annual re-occurrence Interval (ARI) wet or dry season freeboard (i.e. available tank space to accommodate rainfall), which is typically 1.3M or 0.3M respectively. The lease pad or a specifically constructed wastewater storage areas will be bunded to contain 110% of the volume of the largest tank stored onsite.	N/A located on proposed lease pad	<4 persons	During wastewater storage activities.	3-36 months	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wastewater storage tanks may be deployed for extended periods of time to allow ongoing evaporation or treatment. Wastewater from other sites across the basin may also be used to stored onsite, to assist in wastewater treatment/ management. The treatment of wastewater may also be undertaken within origin infrastructure footprint (such as lease pads or laydown yard) to reduce the amount of offsite wastewater trucking.					
Flaring During well testing and where gas cannot be beneficially used, produced hydrocarbons (gas and liquids) will be flared onsite. Two flares may be utilised, with a vertical flare used to manage gas and a horizontal flare used to manage condensate where it is anticipated to be encountered. The vertical flare will be an American Petroleum Industry(API) 537 and a US EPA AP 42 compliant unit, with a 98% combustion efficiency. The vertical flare will have a constant pilot flame, with an autoignition system that provides electrical impulses to a spark plug continuously. If the flare was to go out, the spark would ignite the flare within 1.3 seconds. A horizontal flare may be utilised to combust condensate if produced during well testing. A horizontal flare will been equipped with 3 independent nozzles, located in a 20mx 10m clay lined pit. Flares will be located at least 45m from the surrounding vegetation, with flaring not undertaken during total fire ban periods.	N/A located on proposed lease pad	<12 people during production testing	During exploration activities	During production testing.	
Condensate management (Storage and trucking) Where condensate (liquids rich gas that “condenses” when brought to the surface) is generated, it is separated and stored within double lined condensate tanks. Condensate may either then be trucked offsite for beneficial use or combusted in the horizontal flare.	N/A	1-2 trucks per day	During exploration activities	During production testing.	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Wet season operations Exploration activities (including drilling, stimulation and well testing operations) may occur over the wet season. Where wet season operations are undertaken the following risk controls will be implemented: • All chemicals, fuels, equipment, tanks and materials required for ongoing operations will be stored on-site prior to the onset of the wet season • All equipment required to respond to emergency situations will be on-site; this includes earth moving equipment, vacuum trucks, wireline rigs, cementing equipment etc. and equipment and material to deal with well control issues, spills and other emergency events. • All chemicals storage areas will be bunded, with covers used (where safe and appropriate) to prevent rain ingress and bund overflows • Enclosed tanks will be utilised as the primary measure to store wastewater with enough enclosed tank capacity to store all wastewater on-site • Enclosed wastewater storage volume will be sufficient to manage all wastewater stored onsite • Open working evaporation tanks and mud sumps will have enough freeboard to manage an entire 1:1000 ARI wet season event (not just one (1) rainfall event but an entire season's rainfall total) • Helicopters will be used to transport people and supplies into and out of the site when access is restricted • No transportation of wastewater or chemicals will be undertaken during the wet season unless a risk assessment is undertaken that demonstrates the risk is As Low As Reasonably Practicable (ALARP) and acceptable (as per the Code of Practice) • Wastewater storage area is bunded, which will prevent all off-site release of chemicals and stormwater. • During flowback wastewater, stormwater will be retained on-site via the sediment retention pond prior to release. • Overland flow will be diverted around lease pads.	N/A	N/A	October – May	7 months of the year	
Microseismic Monitoring consists of the following: • **Geophone Deployment:** A week before hydraulic fracture stimulation, up to 9 personnel from the operator or a contractor will access a 30-40km^2 area around each of the proposed lease pad and deploy geophones 10-30 metres apart, the deployment will take up to 7 days. Deployment locations are determined by GPS locator. Deployment will be undertaken on foot with crew supported by light 4WD or All-Terrain Vehicle(s) depending on access and crew size. • **Geophone Retrieval:** After the hydraulic fracture stimulation operations have concluded, up to 9 personnel from the operator or a contractor will access a 30-40km^2 area around each of the proposed lease pad to retrieve geophones. The retrieval will take up to 7 days. Geophones are located using GPS locator, once identified they are retrieved from the ground, with any divot filled in. Retrieval will be undertaken on foot with crew supported by light 4WD or All-Terrain Vehicle(s) depending on access and crew size.	No disturbance required	3-9 personnel.	Deployment of Geophones before stimulation. Retrieval of Geophones after stimulation.	1 month (one week deployment, two weeks Stimulation, one week collection)	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site monitoring and inspections consisting of the following: • **Groundwater monitoring:** Groundwater monitoring bores are required to be installed on the lease pad before the commencement of hydraulic fracture stimulation activities. Groundwater monitoring is undertaken at the site commencing 6 months before stimulation and then quarterly for 3 years after. Groundwater monitoring involves purging a monitoring bore of water, measuring field parameters (level, electrical conductivity) and collecting laboratory samples and • **Site and exploration well monitoring-** an operator or contractor will access the site to perform checks on the exploration well and stability of the site. Checks include pressure readings and visual checks of valve integrity. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed fortnightly. • **Weed inspections-** Access to the site by several contractors/ Origin personnel in light vehicles to identify weeds. In some cases, a helicopter may be utilised. Contractors may perform spot sprays with a NTG recommended weed treatment. Surveys are completed pre and post wet season. • **Erosion and sediment control inspections-** Access to the site by several contractors/ origin personnel in light vehicles to identify erosion or stability issues. Inspection will be used to schedule maintenance to repair any defects identified. In some cases, a helicopter may be utilised to complete the inspections. Surveys are completed pre and post wet season. • **Gas leak detection surveys-** Access to the site by 2- 3 contractors or Origin personnel in light vehicles to perform mandatory gas testing using handheld gas meters. Surveys are completed every 6 months. • **Build up pressure monitoring-** Post stimulation and well testing, the exploration well may be shut in with pressure monitoring equipment installed to monitor build up pressure. This requires the installation of a solar panel and telemetry equipment, with monthly equipment inspections (typically)	N/A	<2-6 people	Fortnightly/ 6 monthly (depending on activity)	1 day per inspection	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Site maintenance (lease pad, camp pad, access tracks and gravel pit) Each site will be periodically maintained, which includes grading, erosion and sediment control repair, vegetation management, firebreak management, weed management, fence repair and all other ancillary activities required to maintain a site and associated with infrastructure. This includes maintenance of the access tracks. The work will be undertaken by civil maintenance contractors and Origin personnel.	N/A	<10 people	6 monthly- pre and post wet season maintenance	<7 days per activity depending on the nature of the activity.	
Well head maintenance Maintenance is completed annually on each well. Maintenance primarily includes valve checking, testing, greasing and (in some cases) replacement, as well as any other activities required to maintain the integrity of the well**.**	N/A located on proposed lease pad	<20 people depending on activity	Annually	< 7 days per activity- depending on nature of maintenance.	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Well intervention- data acquisition and testing Subsurface activities may be undertaken periodically on each of the well to perform maintenance or collect additional information on the properties of the well or the reservoir. These type of well interventions typically include performing cement bond logs, casing pressure tests, running reservoir evaluation or production logging tools, cement and casing remediation activity (if required during the life of the well), setting downhole mechanical plugs and gauges, casing perforation, subsurface barrier maintenance/ installation and production tubing installation/repair or replacement. This generally involves the use of a variety of equipment dependent on the activity being completed. This typically may involve any of the following equipment: completion rig, coil tubing, wireline unit, data van, cement or pump truck, crane, trucks, power generation, support trucks and other support vehicles.	N/A located on proposed lease pad	<20 people depending on activity	Ad hoc requests- typically 2 interventions within the next 5 years	<10 days per activity	
Petroleum well plugging and decommissioning. Once a petroleum well is no longer required, each well will be decommissioned. Decommissioning involves the permanent removal of the well through the placement of cement plugs to isolate the target reservoir from overlying aquifers in accordance with the Code of Practice: Onshore Petroleum Activities within the Northern Territory (Code of Practice). Once plugs are installed, they are pressure tested to confirm the underlying formations have been adequately sealed off. The well head is then removed. A permanent marker is added to indicate the location of the plugged and abandoned well.	N/A located on proposed lease pad	<12	End of well life	<10 days	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Chemical and fuel storage- All chemicals and fuels (diesel) required to support exploration activities will be stored in accordance with the relevant regulatory requirements, including the use of secondary containment (bunding) onsite. The Code of Practice has implemented a range of additional controls, including requirements for routine inspections, emergency response procedures and spill management. Anticipated chemical and fuel volumes vary dependent on activity, but may involve the storage of the following types of chemicals and volumes: • Stimulation and drilling chemicals (friction reducers, surfactants, crosslinkers, breakers, buffers, acids, bases, biocides, scale inhibitors, corrosion inhibitors, clay stabilisers, loss of circulation material, drilling muds, salts etc.) Volumes are typically less than 20KL per chemical, with some chemicals stored at higher (such as pH control) or lower (such as biocides and corrosion inhibitors) volumes depending on their purpose and planned use. • Diesel – typically 100KL stored but may be 500KL if wet season activities are proposed. • Other chemicals and hydrocarbons- such as oils and greases, lubricants, hydraulic fluid, cleaning chemicals, domestic chemicals etc. used to support operations.	0.5ha (on existing lease pad or laydown yard)	N/A	During exploration activities	During exploration activities.	
Waste management: Any waste generated during exploration activities will be stored onsite in accordance with the NT *Waste Management and Pollution Control Act 1998* and Code of Practice and transported offsite to a licenced waste management facility. All wastes (other than drilling mineral waste) will be stored within skips or equivalent and removed from site at the end of each activity.	N/A	1 -2 trucks during operations	During explorations activities	During explorations activities	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures
Groundwater extraction: Groundwater extractions from the purpose built groundwater monitoring onsite or another approved extraction bore (which may include trucking water from adjacent properties) will be completed periodically to support exploration activities. All groundwater take will likely be from the Gum Ridge Formation and will be licenced under Origin's existing Water Extraction Licence (WEL) GRF 10285. A new WEL may be submitted covering take an alternative formation where present. It is anticipated that groundwater extraction volumes to support this program will be in the order of 100- 150ML, primarily used to stimulate the 3 wells. Once drilling and stimulation has ceased, minimal ongoing water extraction from the site will be required.	N/A	N/A	Ongoing to support exploration activities.	During exploration activities	
Traffic management Access to the Velkerri 76 N1 site will be via the newly constructed access track, located approximately 20km west of the Tanumbirini station main access point. Minor traffic disruptions may occur during the construction of the access track intersection with the Carpentaria highway. During this period, a traffic management plan will be implemented, with traffic control utilised in accordance with DIPL requirements. Peak traffic volumes are anticipated to be associated with the drilling rig mobilisation and demobilisation. Traffic volumes may reach up to 44 vehicles per day spread over a 4 week period. During operations (drilling, stimulation or well testing), vehicle movements to the site are anticipated to be less than 10 movements per day. This period is likely to extend typically 60 days per exploration well, 45 days per stimulation and during the duration of a well test (30-365 days). Once the well is suspended or decommissioned, vehicle movements will reduce down to 1 vehicle per fortnight or 1 vehicle per 6 months respectively.	N/A	N/A	During operations	During operations	
Site rehabilitation Within 6 months of the E&A wells at Velkerri 76 N1 being plugged and decommissioned, the site will be rehabilitated. This involves: a) the removal of all surface facilities (well heads, fencing, water bores, tanks etc.) b) deep ripping of compacted surfaces c) recontouring landforms d) respreading of topsoil from the topsoil stockpiles, e) re-seeding (if required;) and f) ongoing monitoring and maintenance of the rehabilitation.	N/A		Within 6 months of the plugging and abandonmen t of all E&A wells	<14 days, with ongoing monitoring and maintenance	

Activity description	Disturbance area	Typical personnel numbers	Timing	Duration	Activity example pictures

3.2 Appendix 2

3.21 Environmental Management Plans

An approved Environmental management plans (EMP) is required to be in place for all proposed regulatory petroleum activities in the Northern Territory. EMPs are submitted to the Department of Environment, Parks and Water Security (DEPWS) detailing the potential environmental impacts, risks and proposed mitigation measures associated with a proposed exploration activity. The plan is also required to demonstrate how it complies with the Code of Practice: Onshore Petroleum Activities in the Northern Territory (the code of practice), which was developed as a recommendation of the NT Inquiry into Hydraulic Fracturing. The Code of Practice outlines a range of minimum standards that must be followed to ensure all impacts to the environment are as low as reasonably practicable (ALARP) and acceptable. Aspects covered by an EMP and the Code of Practice include

- Management of Sacred Site / Cultural Heritage,
- protection of groundwater water resources, including well integrity standards and groundwater monitoring
- Biodiversity impacts from land clearing
- Bushfire prevention and management,
- weed prevention, detection and management,
- Waste management, including solid and wastewater management
- Spill management
- erosion and sediment control,
- protection of Surface water
- environmental nuisance (dust, noise and vibration)
- Community impacts and nuisance (traffic, noise, vibration, dust and amenity)
- Greenhouse gas emission management and mitigation

3.22 Summary of Environmental outcomes, impacts, risk and controls

An overview of the potential environmental outcomes, potential impacts and risks associated with the proposed exploration activities within this clearance request are summarised in Table 3. This information will also be provided in the EMP covering the proposed regulated activity, which will be submitted to the Department of Environment, Parks and Water Security (DEPWS) for formal assessment and approval.

An environmental outcome means an outcome that will be achieved if the environmental impacts and environmental risks of a regulated activity are reduced to a level that is as ALARP, and acceptable.

Environmental impacts are defined as any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity.

Environmental risks are defined as the chance of something happening that will have an environmental impact, measured in terms of environmental consequences and the likelihood of those consequences happening.

Both the consequence and likelihood of a potential impact can be reduced through the adoption of controls, which must be applied to reduce a risk down to an ALARP and acceptable level.

Table 2 Environmental outcomes, impacts, risk and controls

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
Groundwater use and quality	• To manage exploration activities to prevent unsustainable depletion of groundwater resources • Preserve groundwater quality to protect environmental and pastoral use	• No adverse changes to groundwater quantity is anticipated to be associated with exploration activities. • Impacts to aquifers levels anticipated to be negligible, with rapid recharge observed from other Gum Ridge Formation bores utilised within the Basin. • No material changes to groundwater quality anticipated form exploration activities. • No impact to Groundwater Dependent Ecosystem's (GDE) or stygofauna from exploration activities (extraction and well construction) • Reduction in pastoral productivity through reduced groundwater volumes	• Low risk of groundwater contamination from drilling fluids during construction of the conductor/ surface casing in the Cambrian Limestone Aquifers due to the selection of low toxicity drilling fluids • Low risk of cross flow of deep formations (such as the target shales) to shallow aquifers through inappropriate well barrier design and construction due to the presence of the Code of Practice controls and verification processes. • Low risk of crossflow through fracture growth into aquifer from stimulation activities allowing the migration of fluid and gas due to the controls within the Code of Practice and underlying separation distance between the target formation and Cambrian Limestone aquifers. • Low risk of stimulation activity inducing seismic activity that enables cross formational flow between shallow aquifers due to seismic stability of region and lack major faults or fracture zones. • Low risk of stimulated zones intersecting offset wells (including the adjacent horizontal wells) or intersecting an existing geohazard due to seismic control, pressure monitoring during stimulation and lack of older petroleum wells in close proximity. • Low risk of crossflow/well integrity caused by the deviation of an E&A well into the adjacent well during drilling due to downhole GPS tracking tools and proximity alarms • Low risk of leakage of either flowback, produced water, or hydrocarbons (liquid	• All petroleum wells are to be designed, constructed, operated and decommissioned in accordance with the mandatory controls within the Code of Practice. The Code of Practice outlines specific controls measures designed to protect underlying groundwater resources including: ○ Exploration wells designed with multiple cement and steel casing barriers to protect aquifers ○ Drilling fluids and muds must have a low residual toxicity ○ Groundwater monitoring must be completed before and after stimulation to detect contamination ○ Well integrity confirmation to prove barrier performance aquifer isolation (casing pressure tests, formation leak off tests, cement bond logs etc.). ○ Separation between stimulated shale resources and aquifers must be sufficient to ensure the risk of fracture growth is ALARP ○ Pressure monitoring completed to ensure maximum allowable operating pressure is not exceeded during stimulation. ○ Ongoing well integrity monitoring and maintenance throughout the life of each well to ensure aquifers are protected ○ All wells are to be decommissioned in accordance with the Code of Practice, with cement plugs utilised to being added to separate aquifer units.

			and gaseous) from suspended or abandoned wells to groundwater due to well design and integrity management. • Low risk of surface contamination from storage and disposal of drilling fluids, additives, muds and cuttings on-site due to low toxicity of drilling muds and disposal risk assessment process. • Low risk of groundwater contamination from surface spills from storage, handling and transportation of flowback water due to the storage and spill management requirements outlined int eh Code of Practice. • Low risk of groundwater contamination from the storage, handling and transportation of chemicals, fuels and wastes due to the mandatory code of practice controls (such as mandated use of secondary containment) • Low risk of groundwater contamination from overtopping of drilling sumps and flowback tanks (including during wet season) due to level alarms and use of enclosed tanks. • Low risk of groundwater contamination from a failure of flowback storage tank due to the design standards of the tank (cyclone rated steel tank structures) and routine integrity inspections • Low risk from over extraction of groundwater for civils, drilling and stimulation activities due to limited nature of take (one off), yield of the Cambrian Limestone Aquifers and available allocation volumes (as assessed in the WEL).	• All surface storages of wastewater and chemicals to have secondary containment to prevent spills to the ground • An emergency response plan must be implemented outlining how spills and emergencies will be responded to. • Drilling fluids and wastes to be stored within a lined sump • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All open treatment tanks are to be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring (such as a cyclone) • Groundwater monitoring from monitoring bores installed at the site must be completed prior to and after stimulation to detect any contamination. • All water take covered by an existing Water Extraction Licence (WEL) GRF 10285 • New extraction bores must model potential impact on adjacent pastoral bores prior to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
				• .All water take to be metered and reported quarterly to the regulator • No pastoralists groundwater bores within 3 km of the Velkerri 76 N1 site.
Soils	• Avoid, minimise and control soil erosion and discharge of sediment or soil into waterways or established drainage systems • Minimise disturbance of soil, vegetation and drainage during site activities • Prevent the contamination of soil to maintain the viability of soil resources • Minimise residual impacts to pastoralist usage of exploration areas	• Clearing of vegetation to support exploration activities. • Soil compaction from access tracks, leases and seismic lines. • Increased sedimentation transportation from disturbed areas • Loss of productivity of disturbed areas until final rehabilitation has been achieved	• Medium risk of soil erosion from cleared areas (access tracks, lease pads, camp pads, gravel pits and laydown areas) occurring on disturbed sites due to high intensity wet seasons. Risk is a low consequence (minor impact), possible (<50% chance of occurring) event. • Low risk Reduction in land production through poor erosion and sediment control practices • Low risk of spills/leaks from the on-site storing and handling of fuels. Condensate, hydrocarbons, drilling additives, stimulation additives, flowback fluid, solid wastes, storage and transportation of wastes causing soil contamination. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls • Low risk of chemical and waste transportation accident causing soil contamination due to licenced chemical/ waste provider use, spill response and emergency response requirements. • Low risk of contamination from on- site disposal of drill muds and cuttings with site specific assessment completed to ensure disposal is environmentally acceptable.	• Site selected to avoid sensitive soil units and slopes which may increase erosion hazard. • All land clearing (including during the establishment of seismic lines) to align with the requirements of the code of Practice and NT Land Clearing Guidelines (2019) • Erosion and sediment control practices to be utilised at all disturbed sites to minimise erosion. • Sites (including gravel pits) maintained to minimise sediment releases, with erosion and sediment control plan in place • Pre and post wet season monitoring completed on all disturbed areas (including seismic lines) to identify and repair erosion • Construction within the wet season to be avoided to reduce the erosion risk. • Vegetation clearing watercourses to be avoided as far as reasonably practicable (i.e. only when a new access is required to be constructed) • During seismic surveys, vegetation clearing within open woodlands to be minimal • All chemicals and fuels to be stored with secondary containment as per code of Practice.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of wastewater evaporation mist transported offsite during wastewater treatment due to wind speed/direction cut offs and routine site inspections during operations. • Low risk of greywater and sewerage disposal from camp wastewater treatment plants due to the irrigation area being appropriately sized, fenced and quality aligning with the NT Department of Health requirements. • Low risk of reduction in land production through poor infrastructure placement as infrastructure is located along an existing seismic line and no sensitive soil types are present in the immediate vicinity. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements	• During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred • Flowback wastewater must be stored in double lined tanks with leak detection and level monitoring • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All open treatment tanks and sumps are to be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring (such as a cyclone) • Stormwater to be retained onsite during wastewater storage and tested prior to release • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements • Disposal of drilling muds, cuttings and mineral waste to be undertaken in accordance with Code of Practice, with onsite disposal only permitted where the potential harm to the environment can be demonstrated as ALARP and acceptable.

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
				• Site to be rehabilitated back to pre-existing/ agreed state with pastoralist input.
Emissions (dust, greenhouse and combustion emissions)	• Avoid environmental nuisance at sensitive receptors • Minimise impacts to pastoralists and surrounding ecological communities from dust • Minimise greenhouse gas emissions	• Dust on vegetation in the immediate vicinity of activities reduces plant palatability • Impacts of dust nuisance to birds and fauna in the immediate vicinity of activities, specifically access tracks and seismic lines • Emissions from the combustion of diesel. • Generation of Greenhouse gasses	• Low risk of dust impacts generated during Civil activities, drilling operations, well testing due to use of dust suppression and routine maintenance of access tracks and infrastructure • Low risk of reduction in regional air quality resulting from emissions from the combustion of diesel due to the temporal nature of the activities and selection of efficient equipment. • Low risk of reduction in regional air quality from gas and condensate flaring due to the combustion efficiency of the flare and operating procedures. • Low risk of air emissions from chemical releases during drilling and stimulation activities impacting livestock, fauna and people due to chemical handling procedures limiting emissions during mixing. • Medium risk of bushfire from accidental ignition by site activities (civil works, drilling, flaring, grinding) or personnel. The consequence of a fire is considered serious, with the likelihood Highly unlikely. • Low risk of uncontrolled release of gas impacting a receptor during drilling, stimulation, barrier failure, operator error or vehicle collision due to the well design, blow out prevention, well integrity and	• Site located away from sensitive receptors, such as homesteads • Dust suppression to be used on access tracks, lease pads and gravel pits to minimise dust emissions • Dust levels consistent with standard pastoral activities (such as mustering/truck load outs) on the property • Venting of raw gas is tightly controlled under the Code of Practice, with no material volume of gas to be vented • A reduced emission completion (flare) to be utilised to combust all hydrocarbons • Flares to be compliant with USEPA design standards, including 98% flare efficiency • Stimulation chemical mixing procedures deployed (such as enclosed hoppers) that minimises dust emissions • Firebreaks to be maintained around well and camp pads to minimise bushfire risk • Flaring exclusion zones to be maintained around flare • No flaring during total fire bans • Slashing, grinding and other higher risk fire activities to be undertaken with appropriate controls to mitigate he risk of bushfire (such as buffer zones, use of fir trailers,

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			lack of sensitive receptors preventing impacts. • Low risk of leak of gas from wells due to the well design, routine leak detection and repair and separation distance from receptors,	fire breaks etc.) • During seismic surveys, no vegetation is to be mulched and bushfire management protocols implemented. • Vehicles to be equipped with fire extinguishers • 6 monthly gas leak detection on all exploration wells.
Surface Water	• Avoid and minimise the potential contamination caused by the discharge of sediment or contaminated storm water to waterways or established drainage systems. • Contain any potential contaminants for treatment or disposal.	• Increased sedimentation transportation from disturbed areas (access tracks, lease pads, seismic lines etc.)	• Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Low risk of drill sump and flowback tank overtopping due to mandatory freeboard and monitoring controls • Low risk of a transportation accident releasing chemical or wastewater (drilling fluid and flowback) due to the use of licenced wastewater/ chemical transportation providers, spill management and emergency response requirements. • Low risk of spills to surface water from chemicals and fuel storage and handling activities due to use of secondary containment and separation distance to watercourses. • Low risk of stormwater releases from activities contaminating surface water due to stormwater segregation and testing procedures. • Low risk of infrastructure changing surface hydrology and flow due to	• No take of surface water permitted or proposed • Lease pad located approximately 3.2KM from the mapped stream order 1 stream (Williams and an un-named tributary of Jiberu Creek) • Seismic activities to: ○ avoid vegetation clearing as much as practicable ○ In open woodlands, limit clearing to grasses and shrubs ○ Maintain viable root stock to promote rapid rehabilitation ○ Avoid seismic lines in water courses (unless co-located with an access track) • Site maintained to minimise sediment releases, with erosion and sediment control plan in place • Double lined enclosed wastewater tanks with leak detection and level monitoring utilised to store all wastewater, with open treatment tanks used to reduce wastewater volumes • All wastewater tanks engineered to

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			• infrastructure design and avoidance of overland flow locations. • Low risk of changes to terrestrial ground surface levels associated with seismic activity due to the stability of the basin and geomechanical properties of the target and overlying formations.	withstand failure, cyclone rated construction • All open treatment tanks and sumps are to be operated with a 1:1000Annual re-occurrence interval (ARI) wet season or dry season (whichever is applicable) freeboard • All wastewater to be transferred to enclosed tanks within 8 hours of a significant rainfall event occurring (such as a cyclone) • During wastewater storage, the site is to be fully bunded to contain the volume of an entire wastewater tank if a structural failure occurred • All spills of chemicals and wastewater to be cleaned up upon detection. • Irrigation of greywater and treated effluent to be undertaken in accordance with DoH requirements • No offsite releases of drilling or stimulation wastewater proposed or permitted • Stormwater retained onsite during wastewater storage, with testing completed prior to offsite release • Site selected to avoid major structural features, such as faults • Basin is seismically stable, with low seismic activity reported.
Flora and Fauna	• Minimise disturbance to flora and fauna • No disturbance to high conservation areas	• Clearing of vegetation communities (such as Open Corymbia/eucalypt woodland, Bullwaddy and/ or Lancewood) to support	• Low risk of impacts to sensitive vegetation communities from seismic activities, with high ecological areas avoided • Low risk of threatened fauna mortality during clearing, with all sites to be inspected prior	• Seismic activities to: ○ avoid clearing of mature trees and protected flora ○ In open woodlands, limit

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
	• Avoid the introduction of weeds • Avoid the spread of existing weeds • Minimise the loss of pastoral productivity	exploration activities (lease pad extension and seismic lines). • Loss of fauna and flora habitat • Loss of livestock grazing area • Loss of productivity of disturbed areas until final rehabilitation has been achieved	to clearing to avoid fauna. • Low risk of vehicle and machinery noise and lighting on well pads and access tracks causing material impacts to threatened fauna or livestock. • Low risk of contamination from a flowback wastewater tank failure due to the structural design of the tanks, site bunding, emergency response requirements and spill management requirements. • Medium risk of introduction and spread of weeds in the area due to equipment washdowns, inspection and certification requirements. Monitoring and routine treatment completed on identified outbreaks. Impact from weed introductions/spread is considered moderate, with likelihood Unlikely. • Medium risk of bushfire from accidental ignition by site activities (civil works, seismic activities, drilling, flaring, grinding) or personnel on fauna, flora and land productivity. The consequence of a fire is considered serious, with the likelihood Highly unlikely. • Low risk of flora, fauna and livestock being trapped and drowning in storage tanks, sumps and pits due to the design of storages and fencing. • Low risk of contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities due to chemical storage and handling practices. Fences are utilised to restrict livestock access. • Low risk of vehicle collisions with fauna –	○ Maintain viable root stock to promote rapid rehabilitation ○ No seismic lined in riparian ○ Implement fire management controls, include rapid response • No mulching of vegetation to occur which reduces risk to fire • Vegetation to be walked down and inspected for fauna prior to clearing. Where fauna are identified, work shall stop in the immediate vicinity until they leave the area. • Site to be fully fenced during operations • Open pits to be fully fenced to prevent livestock access • Sumps to have fauna ladders or liner material (such as coletanche) with sufficient friction to allow fauna to escape. • Gravel pits to be left open to act as watering point for livestock when not in use • Vehicle speed limit restricted to 60km/hr • Dust suppression used to limit dust impacts to vegetation • Limited night-time activities proposed. • Site to be rehabilitated back to pre-existing/ agreed state with pastoralist • All equipment and loads to be

Aspect	Environmental Outcomes	Environmental Impacts	Potential risk	Controls
			fauna mortality results in a localised impact to listed threatened species, due to avoidance of night-time driving, speed limit restrictions and number of vehicle movements. • Low risk of reduction in land productivity from poor rehabilitation due to mandatory rehabilitation requirements and security bond requirements Reduction in land production through bushfire • Low risk of impacts to flora and fauna through the encouragement of feral animals and other pest species leading to competition with native species. This includes the introduction of cane toads.	inspected and certified weed free prior to entry • 6 monthly weed inspections to be completed with all identified weeds treated. • Weeds sprayed periodically to restrict weed numbers.
Environmental Nuisance and Amenity- including dust, noise, light, odour and vibration	• Minimise impacts to pastoralist operations	• Construction of exploration infrastructure onsite changes land use from pastoral to industrial. • Light and noise nuisance to fauna and livestock in immediate vicinity of activity • Increased traffic to proposed exploration area • Noise, light, odour and dust emissions in the immediate vicinity of the lease pad. • A visible hue visible from operations at at night during flaring or from activity lighting. • Noise impacts from helicopter movements • Noise and vibration impacts during seismic activties.	• Low of changes in property amenity through the construction and operation of exploration infrastructure due to location of activities and separation distance from receptors • Low risk of increased vehicle accident or traffic impacts through associated with no material traffic volumes anticipated and limited peak traffic periods. • Low risk of adverse impacts to fauna from traffic are not anticipated, with impact levels consistent with standard road traffic levels. • Low risk of helicopter movements causing impacts to receptors based on location of site away from homesteads	• Sites located ~10-20km from nearest homestead • Site is located away from pastoralist main access points • Maximum peak traffic during mobilisation and demobilisation is likely to be typically less than<44 vehicle movements per day for 2 weeks. • Speed limit restricted on the access tracks to <60km/hr • Dust suppression to be utilised to minimise dust emissions • Where helicopter movements are planned, the pastoralist to be engaged prior to ensure helicopter do not interfere with pastoral activities. • Seismic surveys to avoid sensitive receptors, such as homesteads, local communities, sacred sites etc.

Appendix N.1.2 20 230725 Letter-Gantt & next steps

From: Matt Kernke
Sent: Thursday, 9 November 2023 3:59 PM
To: Linda Pugh
Subject: FW: Correspondence from Tamboran Resources
Attachments: NLC RFI Response - Annexure A.pdf; Tamboran - NLC Next Steps letter 200723.pdf; Annexure B NLC Letter 240723.pdf; Tamboran Pipeline Shape files.zip; Water bore SDS.zip

FYI

From: Emily Beresford-Cane [redacted]
Sent: Tuesday, July 25, 2023 2:18 PM
To: [redacted]
Cc: [redacted]
Subject: Correspondence from Tamboran Resources

Dear Rory

Please find attached correspondence and associated attachments from Tamboran in response to your letter of 22 June 2023:

1. Letter from Tamboran to NLC.
2. Detailed response to request for information about the Tamboran 2023 Work Program - **Annexure A.**
3. Updated 2023 Work Program Gantt Chart - **Annexure B.**
4. Further Pipeline GIS Shape Files (marked as per NLC GIS guidelines).
5. Water bore SDS information.

Please don't hesitate to contact me if you would like to discuss.

Kind regards

Emily
[redacted]

#	Page referred to in 2023 work program	Question and response
1.	Page 14 and 18 (section 4.2, subsections 2 and 3)	**Please provide details about the environmental baselining assessments proposed and please confirm whether Tamboran will provide the NLC with copies of the environmental baseline reports when completed.** Baseline assessments are divided into 2 parts: Exploration and Development Planning Exploration: Baselines assessments of all proposed areas have been completed covering groundwater, flora and fauna and weeds. These are included in the Environmental Management Plan (EMP) which will be submitted to the NLC. Development: Additional studies are anticipated to be completed to support environmental impact assessments associated with future development. These assessments are necessarily more detailed than exploration studies given they are designed to characterise the environment over the proposed development area (and any other impacted areas). The total footprint of such studies may not cover as large an area as exploration based studies given that development is likely to be targeted around a small number of exploration sites. Studies will include regional groundwater, soil mapping and testing, surface water monitoring, flora and fauna surveys, weed surveys, air quality testing and other activities required to develop a comprehensive baseline. These will be provided to NLC as a part of the development assessment approach.
2.	Page 14 (section 4.2, subsection 2)	**Will the access tracks "to connect all lease pads and infrastructure to the Stuart Highway" be within the ILUA area?** Yes, it is anticipated that access tracks will be constructed within the ILUA area.
3.	Page 15 (section 4.2, subsection 2, paragraph 4, bullet point 4)	**Please provide details regarding the "centralised waste management areas" (eg what waste is to be managed here, what infrastructure will be required etc)** Currently, it is assumed that all wastes generated onsite will manage its own drilling and flowback wastewater. Under a success case, where Tamboran begins drilling multiple wells per site, one or more sites may be selected, designed and constructed for extended wastewater storage; we refer to this as a "centralised waste management area". Where this is the case, drilling fluid and mineral waste (muds, fluid, cuttings, cement and sand) and flowback wastewater from a number of exploration

		locations will be transferred to the centralised area for storage and treatment. A centralised site is proposed to optimise/minimise total infrastructure and impact by limiting the number of tanks required on each location, reducing the required amount of land disturbance and risk associated with multiple tanks operating at one time. Mineral drilling wastes (muds and cuttings) may be "land farmed onsite" to generate useable compost material suitable for site rehabilitation. To enable this, organic material (such as holding yard manure which is available regionally) will be sourced and mixed with drilling waste that has been allowed to dry out in the sump. The material will be mixed and stored in windrows (during the dry season) to compost (similar to how composted and engineered soil is made). This will ultimately reduce waste disposal volumes and create a beneficial product. This is a potential business opportunity for local and/or Indigenous businesses to support
4.	Page 15 (section 4.2, subsection 2, paragraph 7)	**Please provide details/specifications of the "additional wells that are deeper and longer"** The typical vertical depth of 4000m and horizontal length of 5000m is quite conservative and would not be exceeded within the anticipated work program. This statement is designed to provide a level of flexibility for the proposed wells in case the formations are found to be deeper than the prognosed depth. This ensures the specified values do not lock the operator into a hard defined well depth or length. Specifics on well depth will be provided within the routine annual work program report/update.
5.	Page 15 (section 4.2, subsection 2, paragraph 17)	**Please provide details of the "onsite disposal of drilling cuttings and muds through onsite encapsulation or mix-bury-cover techniques".** **Please advise what analysis will be undertaken of drill cuttings and muds (eg what analytes will be tested for and against what criteria) and whether the analytical results will be provided to the NLC and how will such encapsulation or buried material will be maintained during the project and rehabilitated at the end of the tenure.** A description of the activity was provided in Table 3 which answers a large proportion of the question: *All waste drilling fluids, muds, cuttings, DFIT return fluid and cement returns will be managed in a lined drilling sump on-site. Once drilling has been completed, this material will be sampled as per the Code of Practice and a risk assessment completed to determine whether onsite encapsulation or mix-bury-cover can occur in an environmentally acceptable manner. In most cases, drilling wastes will be dewatered, blended with clean fill and encapsulated onsite within an impermeable liner. It will then be buried with capping material to enable vegetation re-establishment. To reduce the number of sites where mix-bury-cover is used, multiple wells from other locations may be disposed of at a selected location.* Further information:

		Drilling wastes will be tested for the analytes in appendix A. These are outlined in section C.4.1.2 of the response taken from the Code of Practice. Upon decision to mix-bury-cover, a risk assessment will be completed to determine if the drilling waste can be left onsite in a safe manner. This risk assessment will involve the collection of site-specific information, such as soil quality, land use type, proximity to sensitive features and depth to underlying groundwater to ensure minimal potential for future environmental harm. This risk assessment can be provided to NLC prior to disposal. Once the material is encapsulated, the site will be monitored until vegetation cover is established and site meets the rehabilitation criteria. A report will be generated and submitted to the NT Government demonstrating how the site has met its rehabilitation guideline that the site has been returned back consistent with pre-disturbed landform and that landform is safe, stable and non-polluting. This report will be provided to NLC.
6.	Page 15 (section 4.2, subsection 2, paragraph 18)	**Please advise what analysis will be undertaken of drilling fluids and wastewater proposed for dust suppression (eg what analytes will be tested for and against what criteria) and whether the analytical results will be provided to the NLC and how the risk of contamination of soil and overland flow etc will be avoided (noting the recent media reports that elevated levels of Barium was found in environmental media following use of drill fluids for dust suppression at Maverick #1 well).** The recent media reports regarding Maverick #1 are not well founded, with clarifying information that Tamboran provided the ABC not included in the reporting. Unfortunately, the 'results' that were provided by Rallen to the ABC were not appropriately scrutinised or contextualised, which has created a misleading sense of fear among some parties. Regardless, the water applied as dust suppression was primarily groundwater from the Cambrian Limestone Aquifer that had been stored in a pit that also contained drill cuttings from the “upper” section of the well (i.e. what water bore drillers generate and apply to the surface during the drilling of each bore). The water used did not contain deeper cuttings from the underlying shales or barite weighted drilling muds. Barium level in the sump for example, were consistent with the underlying groundwater levels. Where drilling wastewater is to be utilised for dust suppression, a risk assessment will be completed, which will including fluid testing by a third party to ensure the application of wastewater

		for dust suppression does not cause an unacceptable risk to the environment. Salt is utilised for dust suppression and ice control in cold climates - with the assessment determining what is the safe thresholds that need to be complied to ensure no long term damage to soil productivity or impact to surrounding environment. The science around protecting soils and the environment is solid, with extensive experience gained through long term irrigation projects internationally. Analytes to be assessed include: • Total dissolved Solids • pH • Major ions (Sodium, Calcium, Magnesium, potassium, chloride, sulphate, bicarbonate • Metals (including Boron, barium, strontium,) • Total Petroleum Hydrocarbons Examples of uses of similar Petroleum sourced wastewater uses are provided below: https://environment.des.qld.gov.au/__data/assets/pdf_file/0028/88660/wr-eowc-associated-water.pdf https://environment.des.qld.gov.au/__data/assets/pdf_file/0027/89361/wr-eowc-irrigation-associated-water.pdf
7.	Page 22	**How many dynamite charges does Tamboran propose to use, over what duration/frequency and what days of the week/hours of the day will they be detonated and where? What safety precautions for NTHs and environmental media (ie potential to contaminate near-surface aquifers) will be in place?** Tamboran proposes to utilise approximately 100-160 charges spaced approximately 2-300m apart. These will be detonated over a 2-4 day period along the seismic lines indicated in Figure 1 of the Work Program update and Clearance Request. No nighttime activities are proposed. A zoomed-in map of these seismic lines is provided in Appendix B of this response-. The seismic charges will be detonated along these lines. The explosive detonation impact will be a dull thud with minimal surface disturbance. The activity will not result in an expulsion of material, with appropriate exclusion zones utilised around the explosives (typically 100m) to protect people. Cattle will be kept out of the immediate area, with no impacts to stock or native animals anticipated. We will advise the NLC the periods for which we are proposing to carry out and will invite Cultural Managers to attend the works.

		The use of seismic charges (dynamite) is an option proposed to reduce vegetation clearing, which is typically required to complete seismic shoots using truck mounted "vibroseis" sources (noting we still may utilise vibroseis trucks instead of or in parallel to dynamite to test its effectiveness). Use of dynamite will reduce land clearing and result in minimal land disturbance. Detonating the explosive will result in a small nitrate release, which will be rapidly consumed within the soil profile by bacteria. Groundwater is not anticipated to be impacted from this activity. Any disturbance to soils from the installation and detonation of the seismic charges will be rehabilitated (essentially backfilled) immediately.
8.	Page 23	**Rehabilitation** **Can NTHs get access to harvest/collect traditionally useful timber (if any) on seismic lines, pipeline corridors, lease pads and other infrastructure footprints prior to clearing? For that purpose, can Tamboran give us reasonable notice of where and when they are going to clear?** This is something Tamboran would be supportive of. Tamboran could provide ~4 weeks notice of completing clearing activities to allow this activity to occur. We would be happy to work with the NLC to facilitate this, however, we'd need to establish jointly if or what other pastoralist or regulatory approvals are required
		Does Tamboran plan to arrange seeding or seedling planting as part of vegetation rehab? Yes- Tamboran will seek to collect a native seed mix in the future sourced from the local area. This is something we would be happy to explore with the NLC in the future to support rehabilitation activities and NTH business development activities.

		Groundwater **"The bores will also be used for groundwater extraction to support exploration activities":** **Can we please have details of:** • **the location and depth of bores** This section pertains to the groundwater bores that will be constructed on each of the 6 proposed lease pads in each of the proposed new clearance areas of the Shenandoah South and Amungee NW extensions areas (12 lease pads in total). as outlined in section 4.2.2. the exact location of these lease pads is not known at this time, with the clearance request designed to clear broad areas to allow for infrastructure to be located with a high degree of flexibility to accommodate scouting and pastoralist input. The bores will be constructed to penetrate both the Anthony Lagoon Formation and Gum Ridge Formation. The depth of the bores is unknown until they are drilled, but will nominally be between 150m for the Anthony Lagoon bores and 400m for the Gum Ridge Bores. **bore surface disturbance area, pump and surface infrastructure** Bores will be located on the existing lease pad, typically 10m2 per bore. Each bore will be installed with: • Head works and piping • A water take meter as per DEPWS water resources requirements • a submersible pump with a generator to provide power • monitoring equipment (sensors), solar panels and telemetry. **MSDS sheets for chemicals to be used in drilling, operating, maintaining the bores (eg bactericides, surfactants etc)** Each bore will be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australian which governs the construction of all water bores drilled in the Northern Territory. The anticipated chemicals utilised in future water bore drilling campaign are attached to this submission. The minimum construction requirements for water bores in Australia is located here : https://adia.com.au/wp-content/uploads/2020/09/Minimum-Construction-Requirements-Edition-4.pdf

		aquifer draw-down/recharge modelling Tamboran has provided this information to the NLC on the 30/06/2023 as a part of its proposed future Water Extraction Licence Submission. These drawdown curves are provided in Appendix D.

		• **details of analytes etc to be tested in baseline assessment and on ongoing basis** The analyte list is defined in the Code of Practice for onshore petroleum activities in the Northern Territory and Preliminary Guideline: Groundwater monitoring bores for petroleum wells in the Beetaloo Sub-basin. A copy of the analyte list has been provided in appendix C to this response. Code of practice available here (refer table 6): https://depws.nt.gov.au/__data/assets/pdf_file/0011/705890/code-of-practice-onshore-petroleum-activity-nt.pdf And Preliminary guideline for groundwater monitoring available here (refer table 2): https://denr.nt.gov.au/__data/assets/pdf_file/0009/618957/Preliminary-Guideline-Petroleum-Well-Water-Quality-Monitoring.pdf • **access to baseline assessment results and ongoing monitoring data** Groundwater monitoring for wells to be hydraulically fractured will be completed quarterly before stimulation (baseline) and 3 years after stimulation (ongoing compliance) . Results are provided to the Government Quarterly, with those submissions provided to NLC. • **bore works development permits** Bore work permits are submitted to DEPWS prior to the drilling of each bore. As these bores are not yet approved to drill, these permits have not been completed. • **service life and decommissioning plans** bores are anticipated to be transferred to the pastoralists (where accepted) once they are no longer required. Where the bore is not proposed to be transferred, it shall be plugged and abandoned as per the Minimum Construction Requirements for Water Bores in Australian guideline. The management of bores will also be covered under the Environmental Management Plan. • **volume and fate of waste bore water following use to support exploration activities etc.** Any water produced during bore development work will either be beneficially used (i.e. for dust suppression or construction purposes) or discharged to grade in a manner that reduces the risk of

		erosion. The volume of water produced will depend on how long the formation takes to clean up and will typically be in the order of 0.25 to 2ML. • **water discharge licence and volume of waste water to be discharged to land** A water discharge license is not required for bore development works. This is authorised under an EMP. Water will be preferentially utilised, with typical volumes of 0.25 to 2ML- depending on how long the bore takes to clean up post drilling. • **volumes of water which Tamboran is licenced to extract** Tamboran is currently authorised to extract 175ML/year form the Gum Ridge Formation under GRF 10285. This is proposed to be increased to 450ML/year. A summary of the application to increase was sent to the NLC on the 30/06/2023. **Regarding the following:** • **a. "'The fluid (which is anticipated to be fresh) will be discharged to grade and the area surrounding the lease"; and** • **b. "waste cuttings, drilling fluids, muds and formation fluids",** **please provide details of the analytical testing proposed in respect of the same (eg what analytes will be tested for and against what criteria) and whether the analytical results will be provided to the NLC.** **Analytical testing of water bore drilling cuttings, fluids and muds** The proposed management of bore water and drilling waste is consistent with all industries across the Northern Territory. Waste material will be managed in accordance with the Minimum Construction Requirements for Water Bores in Australian guideline. This is an Australian standard and required by the Northern Territory Government. Water bore drilling cuttings and muds will not be tested prior to disposal given they are not considered a listed waste due to their low toxicity, small volumes and inert nature. The majority of material will be limestones, sandstones or mudstones which represent a low risk. Bentonite, an inert clay, is the main drilling mud additive. Any listed or general waste generated will be trucked offsite to a licenced waste facility.

		During bore development, pH and EC data will be collected routinely. This will be included in the bore completion report and available publicly. A full suite of analytes in Appendix C will also be taken form the water. The bore completion report and testing results will be provided to NLC in accordance with the Exploration Agreement. **Please also advise how such materials incorporated in lease pad surface will be rehabilitated at the end of tenure.** **Rehabilitation:** Typically, the material will be raked or mechanically mixed into the lease pad surface. This is how water bores manage this material due to its low risk. Rehabilitation of the site will be in accordance with the EMP. Upon rehabilitation of the site, the site will be recontoured, deep ripped to reduce compaction and have topsoil re-spread over the area and a native seed mix introduced if required. The site will be monitored until rehabilitation success criteria has been achieved. Once the success criteria has been achieved, Tamboran will apply to the NTG for acceptance of the rehabilitation and the financial bank guarantee will be released.

		Lease pads **What will be done with spoil excavated from flare pits and well cellars etc?** The site will be stripped of topsoil, with the topsoil stockpiled on the edge of the lease pad typically below 1.5m high to protect seed bank viability. Where the subsoil is different from the topsoil, excavated subsoil material will typically be utilised for sump batters or stockpiled separately around the edge of the lease pad or a designated storage area. It will be stored until it is needed for the site rehabilitation. **What is the rehab plan for drill sumps and waste water ponds?** Drilling sumps will be either a) removed of waste material and liner and then backfilled with embankment material. Topsoil will then be respread. Or b) where a risk assessment determined it safe, the drilling waste will be dried out, mixed with batter material to stabilise and reduce chloride concentrations, the embankment liner folded in on itself, a cap placed over the sump (most likely a liner or equivalent) and approximately 500mm of clean fill placed over. Topsoil will then be respread (typically 100mm) and a seed mix added. **Please provide additional information regarding structural integrity and construction method of the "bund" referred to in this section (noting the inadequate construction and failure of the bund on the Maverick #1 well).** Bunds will be constructed using topsoil topsoil/subsoil. They will be constructed in a manner that ensure they are a) of sufficient height for their location (i.e. in low points of the site they will be high enough to deal with accumulations of water), have sufficient width (typically 1-3m wide depending on required height) and are appropriately battered (i.e. ~1:1 batters). The bund will be constructed in layers, which will each be track rolled to ensure adequate compaction. At Maverick 1, the material was simply pushed up into a windrow by the contractor – a practice that has not occurred at any other of Tamboran's sites. Tamboran has included specific bund requirements into its design standards and erosion and sediment control plans to ensure this does not occur in the future.
9.	Page 24	**How many kilometres in total of gathering lines and pipelines and where located, which wells will be connected to the reticulation network, when will gathering works be constructed, how long will construction take, vehicle movements during construction, what rehab for gathering line and pipeline corridors following construction, what surface signage on underground**

		Please note that all responses regarding pipelines should be considered preliminary and will require engineering design work; we anticipate progressing such work with the APA group, who Tamboran recently announced as our Beetaloo midstream/pipeline partner. **Pipeline lengths** *Gathering lines:* It is anticipated that each site will be connected by an approximately 3-5km gathering line, giving a total distance of 60km (6 locations within both the Shenandoah South and Amungee Delineation area gives 12 sites at 5km per site). Gathering lines will be located between the wells. The location will be determined based upon the final location of the well and placed to meet ecological, cultural, heritage and pastoral constraints. The final location will be field scouted with NTH's as part of the infrastructure placement process (which is the current process for all infrastructure). It is unlikely gathering will be undertaken unless a production licence has been awarded and development is progressing, so we would anticipate further conversations regarding gathering as part of the ILUA negotiation process. *Interconnector pipeline:* Within the Shenandoah South area, there are currently two routes under assessment, both of which have been provided to the NLC. For the Amungee extension area, it is foreseeable that a sales gas pipeline would be required within the cleared area to support future appraisal gas sale. The location of this pipeline has not been determined - thus this request is for a broader area to cover such future flexibility. The final length and location will be determined in consultation with the NTH/ Pastoralist, ecological scouting and also the pipeline engineers (based on the most suitable tie in location). We anticipate that the length within both of the cleared areas would typically be less than 30km. **Which wells to be connected** The connection of wells in either the SS or Amungee areas will be heavily well result dependent. Whether any specific location will be connected has not been finalised, with the clearance designed to provide for an area where future connections can be considered. Locations will be finalised

		through a process of pastoral engagement and field scouting involving ecologists, heritage consultants and NTH's (we do this currently through the NLC). The locations of these sites will be included in subsequent annual work program updates which are required prior to undertaking the works. **When will gathering works be constructed,** It is anticipated that gathering will be completed once well test results indicate that longer term production testing is warranted. This is likely to be within 12 months post positive result from a site. It is possible that once good well tests are returned from several sites, that gathering lines could be constructed in parallel with the lease pads to reduce the amount of onsite flaring (so that wells flow into gathering lines for appraisal gas sale rather than flaring). **How long will construction take** Construction of a 3-5km gathering line would typically take less than 4 weeks. **Vehicle movements during construction**, Typically less than 20 people (~10-15 vehicles) at a time to support the clear and grade, trenching, welding, pipe lowering, and backfilling and landform reinstatement. Traffic would be a mixture of light vehicles and trucks similar to road construction. **what rehab for gathering line and pipeline corridors following construction,** Reinstatement involves back-filling of separated subsoils and respreading of topsoil. Felled vegetation will be placed over the disturbed areas to aid in stabilisation. Typically the site will then be allowed to naturally regenerate using the available seed bank within the topsoil. Where reinstatement fails, additional topsoil, fertilisers and/or seeding may be utilised. The site will be monitored for subsidence and erosion, with repairs completed routinely. **what surface signage on underground infrastructure?:** Signage will be installed in accordance with the *Code of Practice; Upstream Polyethylene Gathering Networks - CSG Industry*. Signage above the pipeline will vary depending on the underlying land use location of the pipeline etc. (such as proximity to roads, creek crossings etc.).

		How will pipeline and gathering lines be rehabilitated following decommissioning? For below ground pipelines, they will be purged of all material, blanked off at each valve pit and valve pit surface infrastructure removed. The pipeline is inert, with the damage and cost of removing the pipeline not worth the benefit of removing. Signs will be removed and the area allowed to return back to normal. Additional seeding may be required to reinstate woody vegetation - but typically this occurs naturally
9.	Page 24	**What will be the configuration and footprint of compressor infrastructure (eg a single central compressor station, or multiple field compressor stations or both)** It is anticipated that a small, centralised compressor would be utilised. Well head compression may also be required to assist in transporting gas to the centralised facility. **What is the diameter of the steel pipeline and gathering lines (what material are gathering lines made of)?** Subject to final engineering design works, our preliminary view is that any substantial interconnectors or trunk-lines would be steel pipe of ~4-10 inches diameter, with gathering lines anticipated to be 5 inch HDPE lines. **Will there be pipeline pig stations serving the pipeline and what will be done with purged waste?** Yes, it is anticipated that a pig station will be located at both ends of the main pipeline. Hydrotesting water will be tested and if the criteria meets the required specification (yet to be established, but typically with a pH of between 6-9 and an electrical conductivity of below 2000us/cm), it will be released to grade. If it does not meet the required specification, it will either be re-used as process water or disposed of as a regulated waste. **Will there be high point vents, low point drains and/or telemetry infrastructure (eg telecom towers etc) on the pipeline or gathering lines? If so how many and at what intervals?** High point vents and low point drains may be utilised; but are not anticipated. If utilised, they will be located every 1km or so depending on terrain. The gathering line pressure is anticipated to be higher than CSG pipelines (300psi versus 100psi), reducing the criticality for HPV's or LPD's. Material volumes of water are also only generated during flow-back. . **Will drones be used to inspect gas infrastructure on-country?**

		Yes. Drones will be typically used to survey disturbance. Normal inspections will be via vehicle. **Will the pipeline use cathodic protection? If yes, what spec and where located?** Pipeline cathodic protection will be designed in accordance with Australian standards (AS2832.12015). The location of the cathodic protection will be determined based on the final design and location of the pipeline. **What is to be done with cleared vegetation?** Cleared vegetation will either be pushed into stockpiles adjacent to disturbed areas or mulched and stockpiled adjacent to cleared areas (in a manner that prevents combustion). Both Felled and/or mulched vegetation will be used during pipeline/disturbed area reinstatement and stabilisation. **Will there be "produced water" from the wells and what volume is anticipated?** No- the shales are desiccated with no formation water that flows during production. **Does Tamboran propose to conduct Land Spraying While Drilling (of spent drill fluids, flowback fluids etc)?** Not in this proposed clearance request. Whilst not discounting the future potential for this activity, the specific environmental factors of the Beetaloo would require special management i.e. lack of cleared areas for application, periodic inundation, dry season application risks (i.e. vegetation smothering), grazing reduction in palatability etc. **Can we please have details about the proposed "centralised processing facility":** **What footprint, where, what infrastructure, when to be constructed, how long will construction take, vehicle movements during construction, dust suppression measures, noise modelling, noise mitigation measures, lighting, flare stacks, fencing, workers camp, energy source etc.** The details or the proposed facility are provided under the activity description "Appraisal gas sale"; in Appendix D Table 3 of the Work Program update and Clearance Request. Within each of the proposed clearance areas, the temporary centralised gas processing facility is likely to be located in close proximity to one of the proposed well sites, with the location to be selected in consultation with Native Title Holders during field scouting (i.e. this request is for the identification of sacred sites within a broader area which is the first step in choosing a potential

		location for future facilities in combination with other operational factors such as resource productivity). The temporary facility is anticipated to be less than 9 hectares, including: • Filter coalescer to remove particulate matter and entrained liquids which could damage the compressors • Dual run ultrasonic metering skid for custody transfer accuracy gas metering • compressor packages • Fuel gas conditioning system, including fuel gas metering • Station piping with pneumatically actuated valves where required • Station vent and blowdown facilities • Pipeline cold vent and blowdown facilities • Electric motor driven fan cooled gas coolers, to cool gas discharged from the compressor unit to a temperature equal to or less than the maximum allowable pipeline inlet temperature • Air compressor packages each with dryers and receiver • Gas fired power supply • Gas Engine Alternator (backup) • Control room housing equipment designed for unattended remote operation of the station • Spare coated line pipe laydown area • Liquids collection tank and drainage piping for liquids collection from station inlet filter • Workshop/storage building and separate lube-oil storage compound • Office and amenities facility • Site security fencing, access roads and drainage • On-site service, demineralised and fire water storage • Pig receiving facilities. The facility is skid mounted and likely to take approximately 8-12 weeks to construct and commission. Existing camps in the region will be utilised where possible or a small camp constructed to support the activity. The remote location of the plant means there are no sensitive receptors in the vicinity of the cleared areas in respect to lighting and noise impacts . For the Shenandoah South Pilot Area, the closest receptor is the Shenandoah/ Hayfield Pastoral homestead which is ~3.5km from the clearance area

		and Jingaloo Aboriginal community approximately 18km Sth of the clearance boundary area. For the Amungee Delineation area, there are no sensitive features within 20km's of the clearance area. The facility will comply with the NT noise management framework. Noise modelling has been completed for the proposed temporary facilities and this will be included in the Environmental Management Plan (EMP). Given the remote location, noise mitigation will primarily be focused on OHS requirements which will reduce offsite noise emissions. The EMP with noise assessment information will be provided to NLC. Light emissions may be visible at distance during flaring, with a visible hue likely visible under certain conditions for 10kms (estimate based on previous flaring campaigns). Minimum lighting required to satisfy OHS requirements will be utilised. The facility is not be located on a regional high point, with lighting impacts considered minor. The facility will be fenced. An example of what a facility could conceptually look like is provided in Appendix E of this response.

#	Page referred to in 2023 work program	Question
10.	Page 25	**Blasting of rock in trenching: over what duration/frequency and what days of the week/hours of the day will there be blasting and where? What safety precautions for NTHs will be in place?** There are currently two proposed pipeline routes with the NLC for feedback regarding Native Title Holder consultation. Once a preferred route is defined, then a geotechnical assessment will be completed to identify potential blasting requirements. However, given the location of the proposed pipelines and underlying soil types, blasting is not anticipated. Blasting will be undertaken as required and during daylight hours. A reasonable assumption for maximum total duration of blasting (given we are not anticipating any) is ~100-160discrete blasting events over a 2-4 day period. Given the remote location and distance from sensitive receptors, blasting is not anticipated to impact any NTH.

#	Page referred to in 2023 work program	Question

The safety precautions for NTH are the same as for the general public. Standard blasting exclusion zones will apply in accordance with Australian/Industry Standards. Ongoing engagement with NLC and standard activity notifications with NTH's will be completed to ensure awareness of the activity and intention for any blasting.

Can we please have a copy of the EIS and EMP referred to at the top of page 26
For the main pipeline, an EIS (or other environmental assessment tier under the NT Environmental Protection Act) and EMP is anticipated to be completed for the main pipeline as a part of the regulatory approval process. This will be provided to the NLC once completed.

How much water will be required to hydrostatically test the 40 km pipeline and where will Tamboran obtain such water and what will be done with the water following testing?
It is anticipated that less than 0.5 ML of water will be required to support hydrotesting. This water will be sourced from the Gum Ridge Formation under Tamboran's Water Extraction Licence. The water will be tested and either beneficially used (such as dust suppression or for drilling/stimulation make up water) or discharged to grade in a controlled manner.

What quantity of gravel to be extracted from gravel pits and how deep will gravel pits excavate to, how will gravel pits be rehabilitated?
Up to a total of 50,000m3 of gravel may be nominally taken from pits specified in the clearance request. The likely figure actually extracted is anticipated to be materially less than this.

Information regarding gravel pit dimensions and rehabilitation is covered in Appendix D Table 3 of the Work Program Update and Clearance Request.

Once gravel extraction activities are finished, the pit will be reshaped, with subsoils re-instated. Topsoils will be spread and fallen vegetation returned to aid site stability. The area will be temporarily fenced (where required) to allow vegetation regrowth. Seed maybe added to the site to support natural regeneration if required. The pits may be converted to pastoral watering points where appropriate and approved by pastoralists.

#	Page referred to in 2023 work program	Question
11.	Page 26	**Where will the workers camps be located and what will be the size of the grey water and effluent irrigation area and where?** The camp pad will be located adjacent to each of the proposed well pads within the cleared area. The wastewater irrigation area will be located adjacent to the camp, with approval obtained from the NT Department of Health administrative procedures to install a wastewater management system outside a building control area. A schematic is provided in appendix E of this response. The exact location of the wells will be determined through future scouting, which will include NTH consultation, endorsement and inclusion in future work program updates. This work clearance report is for sacred site avoidance which will ensure activities can be located in the future to avoid sacred sites.
12.	Page 29	**Please provide a copy of the Code of Practice referred to and details of the risk assessment proposed in respect of the proposed on-site disposal of solid waste.** https://depws.nt.gov.au/__data/assets/pdf_file/0011/705890/code-of-practice-onshore-petroleum-activity-nt.pdf Section C.4.1.2 requires a risk assessment to be completed by a certified suitably qualified third party that the material is of acceptable quality for disposal to land by the proposed method and that environmental harm will not result from the disposal. This risk assessment is a site-specific assessment generated once the a) site has been determined and contextualised and b) the quality of the drilling waste has characterised. This risk assessment is provided to DEPWs prior to onsite burial and will be provided to the NLC as required under the Exploration Agreement.
13.	Page 32	**Please let us have details of how the "import of subgrade fill materials" are to be rehabilitated at the end of the tenure.** The subgrade fill material will be left in situ. This will be inert material, such as bedding sand.

#	Page referred to in 2023 work program	Question
14.	Page 33	**Is there to be a centralised waste water facility? If yes, What footprint, where located, what infrastructure, when to be constructed, how long will construction take, vehicle movements during construction, noise modelling, noise mitigation measures.** Yes, to reduce the number of tanks being constructed at each site, it is logical that tanks on one site may be used to store fluid from other sites. This will: a) Reduce the overall number of wastewater tanks and sumps constructed. b) Reduce lease pad clearing levels as the number of tanks required on each site is reduced- i.e. allow for minimum disturbance lease pads. c) maximise wastewater recycling between sites. Essentially, instead of constructing 6x ~10 hectares sites each containing 5 or 6 large wastewater tanks and a sump, it is proposed to construct 1x ~ 10-hectare site with 5 smaller sites (~3-5 hectares). Wastewater and drilling wastes will be transferred into the 1 site for centralised management. The only change being the transfer of material to 1 site, rather than storage of material on each site. A centralised waste facility may be constructed at one exploration site, which is central to the other sites. This site will likely be the first drilled in an area, with subsequent well sites constructed around it ~ 2-5kms ("stepped out"). Typically a centralised facility only makes sense when drilling and stimulating multiple wells on a pad. Thus, if well test results are poor, a centralised facility is unlikely to be required as future drilling is unlikely to be justified. Where a centralised facility is utilised, drilling waste will be stored on each site in a smaller above ground tank(s) and trucked to the central sump periodically. This could result in up to ~40 trucking movements to transfer the cuttings/muds to the centralised facility (assuming trucking of 37m3 per load and 1500m3 of waste per well). Noise modelling is not relevant as this will be standard construction noise. The site is remote- likely to be 18km+ from the nearest local community.

#	Page referred to in 2023 work program	Question
15.	Page 34	**How many new well pads are proposed in connection with the 2023 Work Program?** 2023; as of July 7 only the use of Kyalla 117 N2 (for Shenandoah South 1H) and Amungee NW (for Amungee NW 3H) are proposed. No new well pad construction is anticipated at this stage. In the clearance request, 6 new well pad locations are proposed for each of the Shenandoah South Pilot area and Amungee Extension areas. **Drilling Waste Management** **Can we have a copy of the "Code of Practice" referred to in this section.** https://depws.nt.gov.au/__data/assets/pdf_file/0011/705890/code-of-practice-onshore-petroleum-activity-nt.pdf Section C.4.1.2 is relevant to this item. **Can we have details of the "risk assessment" to be conducted in respect of the drill waste (eg what analytes will be tested for and against what criteria).** Analyte lists are provided in appendix A. A site specific risk assessment will be completed by a suitably qualified person prior to any mix-bury-cover operations. This will be provided to the NLC once it is completed for a specific site prior to any disposal activities. An example of a risk assessment for Kyalla 117 N2 is provided with this information for reference. **Can we have details of the drill waste encapsulation arrangements proposed (eg where will the encapsulation works be located, what are the dimensions and spec of the encapsulation works and membrane, what is the service life of the encapsulation works and membrane, what volume of drill waste is proposed to be stored in the encapsulation works, what ongoing environmental monitoring will be carried out in respect of leachate, emissions to air etc, who will be responsible for maintaining the encapsulation works and membrane during and following the end of Tamboran's tenure, etc)**

#	Page referred to in 2023 work program	Question
		A schematic of the proposed mix-bury-cover strategy, along with supporting information provided in Appendix F. Mix-bury-cover activities may be completed at each well location upon completion of a risk assessment. Mix-bury-cover will only be utilised where safe to do so and determined through an independent risk assessment to have no unacceptable risks to the environment. The risk assessment will be provided to the NLC prior to the commencement of activity. Typically, 750m3 of waste will be generated per well. Encapsulation will utilise a coletanche, or similar, liner (~300 year liner life). The material will be dried out to remove entrained moisture. The material will then be mixed with clean subsoil (most likely from within the sump batters), liner folded in on itself and an impermeable liner placed over it. A clean fill layer will be placed over the material (~500mm) to facilitate vegetation rooting, with an additional 100mm of topsoil added. The site will then be seeded and fenced off to allow vegetation to re-establish. Monitoring will be undertaken for a period until vegetation has been re-established, the site is stable and non-polluting and the rehabilitation criteria has been achieved. A third-party assessment will be undertaken signing off on the rehabilitation (including assessment to ensure no long-term liability/hazard to the environment). An application will be made to the government to approve the rehabilitation and the bank guarantee for the site will be returned to Tamboran. Risks to the environment are typically reduced through the following: • Nature of material and low migration potential. Drill cuttings are predominantly bentonite which swell and retain water. Bentonite muds generally act as a barrier for fluid movement and will lock in salts limiting migration even if a liner became degraded. Bentonite is often used to line ponds/dams due to its ability to hold water. • Separation distance to aquifers: the regionally significant Cambrian Limestone Aquifer is typically 70m or greater below the surface. Any migration of salts (noting that bentonite will reduce movement) would be unlikely to reach the aquifer at elevated concentration due to entrapment within soil profile (directly underneath sump) and dilution. Management/burial

#	Page referred to in 2023 work program	Question
		of the material below the root profile is the main way of minimising impacts to the environment. This is a typical process used to manage salinity in irrigation practices where chloride levels are pushed below the root zone to protect vegetation. • Beyond 100 years, progressive decay of the liner will slowly release material- noting most will be entrained in the muds. This slow release will have minimal impact through dilution (with the soils of the NT being very low in chlorides). Based on separation distance to aquifer, dilution potential and slow diffusions of material- no long-term impacts are anticipated. The elevated material is anticipated to stay in close proximity to the sump.
16.	Page 35	**Can we have details of the bunding (ie construction spec) to be constructed in respect of chemical storage areas, waste water storage areas and fuel storage areas etc.** Diesel shall be stored within double skinned tanks in accordance with AS1692-2006 and AS1940-2017. Fuels and combustible liquids shall be stored in accordance with AS1940; storage and handling of flammable and combustible liquids. Wastewater is to be stored in double lined wastewater tanks in accordance with section A3.8 of the Code of Practice. Chemicals are to be stored in accordance with section A3.8 of the Code of Practice and AS 3833-2007 (the storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers). Code of practice link here: https://depws.nt.gov.au/__data/assets/pdf_file/0011/705890/code-of-practice-onshore-petroleum-activity-nt.pdf **What testing will be conducted in respect of stormwater prior to release (what analytes)?**
23		

#	Page referred to in 2023 work program	Question

Stormwater that is collected onsite will be tested prior to release. Testing is undertaken for electrical conductivity and pH prior to release. Monitoring parameters are provided below.

Table 16: Stormwater release and re-use limits

Monitoring parameter	Release limit	Limit basis
Off-site release and dust suppression		
Electrical conductivity	1300µs/cm	Irrigation Salinity values used due to the absence of adjacent watercourses, with the protection of soils the most relevant environmental Value (EV). The Guideline was based on the irrigation water salinity ratings for moderately sensitive crops. sources from Table 9.2.5 of the ANZEC Guidelines (2000) Volume 3, Chapter 9, Primary industries, Sodium adsorption ratio (SAR) of stormwater is anticipated to be low, well below <20 . Receiving soils are sandy loam (as described in section 4.1.3), with SAR in irrigation water > 20 permissible which will not increase the sodicity of soils (Table 9.2.6 ANZEC Guidelines (2000) Volume 3, Chapter 9, Primary industries.
pH	6.5-9.5	Limit based upon the background surface water quality data[10] and Table 8.2.8 of the ANZECC Guidelines 2000 volume 2 Aquatic ecosystems-rationale and background information.

What modelling has been done of overland flow diversion around well pads and what countermeasures will be used to prevent scouring, erosion, sedimentation etc from diverted overland flow?

Flood and overland flow modelling is completed as a part of the land condition assessment for any proposed lease pad. This is included in the EMP which will be submitted to the NLC.

#	Page referred to in 2023 work program	Question
		The flood modelling guides the placement and orientation of infrastructure to ensure lease pads are not placed in regional flow paths. An erosion and sediment control plan (ESCP) is developed for each site, including detailed drawings outlining flow diversions and erosion and sediment control measures deployed. This includes clean and dirty water diversions using berms, rock check drains, placement of felled vegetation etc.
17.	Page 36	**Will there be a weed baseline assessment and can we have a copy?** Weed baseline assessments are completed as a part of the scouting for each proposed well site. This will be provided to within the land condition assessment included in the EMP. This will be provided to the NLC. **What herbicides will be used to treat weeds, how often and in what volumes**? NTG recommended herbicides will be utilised selected in accordance the weed control options (page 17) from the NT Weed management Handbook (https://nt.gov.au/__data/assets/pdf_file/0004/233833/nt-weed-management-handbook.pdf). The application volume will be dependent on the type of weed, its maturity and size of infestation. Typical herbicides used are Glyphosphate, Triclopyr and fluroxypyr - the chemical chosen is usually the decision of the contractor who undertakes the treatment (such as Triple P). **Can we have details of the gas leak detection surveys (eg what areas will be surveyed, what gases will be surveyed (eg methane, radon) and how will the surveys be conducted, will soil methane be baselined and monitored ?** Current methane detection programs are restricted to method 21 Leak Detection and Repair (LDAR) assessments of well heads. This is defined by Schedule D of the Code of Practice. Methane is the only relevant parameter for gas detection as radon and other gases occur at too low a concentration, rapidly dissipate and are not good indicators for leaks. Radon is required to be monitored in the gas stream to ensure the gas meets the pipeline specification - not because it represents a hazard to the environment/community. Ethane is often used to differentiate deeper

#	Page referred to in 2023 work program	Question
		thermogenic sources to shallow/surficial biogenic sources (such as shallow bacteria generic methane in aquifers) - but is not typically monitored during Method 21 LDAR programs. Methane baseline surveys have been completed by CSIRO and are likely to continue periodically. Operators may be required to complete these, though the value of these is questionable. Soil methane is important for basins where coals occur or are common (such as the Surat and Bowen basins), and outcropping coal at surface creates a pathway both naturally (natural seeps) and anthropogenically (i.e. through gas migration from CSG or through historic coal bore abandonment). In the Beetaloo Basin, there are not coals and the shales not a gas migration conduit. Even at surface around the edges of the basins, the targeted shales will not conduct material gas and these areas won't have any exploration/development as they are too shallow and structurally complex. GISERA is fingerprinting a seep on EP 161 around the edge of the basin - which is away from any of the proposed activity in this work program. These seeps are natural and the fingerprinting is more for an understanding of their source. As a part of a future development, regional monitoring is likely to be undertaken. Information on our LDAR programs are also provided in the EMP, including a methane emission management plan. **What telemetry equipment will be installed on wells (eg telecom towers)?** During exploration, it is likely that any telemetry will be restricted to site specific systems (such as small solar power well head systems and larger site satellite systems), which have a very restricted range of typically less than 1km. No large radio towers, repeaters or telecommunication towers are proposed. During a development, these types of infrastructure will be installed and will potentially increase regional telecommunication access. **Will there be any preferential arrangements in place to assist indigenous civil maintenance contractors to secure maintenance contracts**? We currently have contracts in place with Indigenous contractors to perform maintenance work. We prioritise the use of Indigenous contractors and further commitments will be negotiated as part of the ILUA.

#	Page referred to in 2023 work program	Question
		As this is exploration, Tamboran is constrained by both internal resource constraints and long-term certainty of future development potential, given positive exploration results, we anticipate opportunities will increase, with resourcing available within Tamboran to support. This is a core focus area of Tamboran and seen as critical to support future resource development within the Beetaloo.
18.	Page 38	**How often will well interventions be performed on each well? What do well interventions entail?** Well interventions are completed ad hoc as required to either address a potential issue (i.e. such as nitrogen lifts to encourage gas breakthrough, well clean outs, diagnostic testing etc.). Well interventions may involve a smaller completion rig or can be rig less using coil tubing or wireline units.
19.	Page 40	**Will access tracks be constructed level with surrounding land? What erosion prevention measures will be used in respect of tracks (eg whoa-boys etc)** Access tracks will be constructed in accordance the NT Pastoral track standard (generally pastoral track 2 standard.). Access tracks will have various levels depending on landform and soil types. Each road will be constructed with an appropriate fall to prevent water pooling on the road surface. Drainage channels and cut outs are constructed to manage stormwater and discharge away from the road surface. Culverts, drains and watercourse crossing are used to ensure overland flow is not impeded. Construction of erosion and sediment controls will be constructed in accordance with a Certified Practitioner in Erosion and Sediment Control (CPESC) accredited erosion and sediment control plan. This is attached to the EMP and will be provided to NLC. This does include the installation of controls such as whoa boys, cut out drains, flow diversions, rock check drains etc.

Appendix A- Drilling waste analytical suite

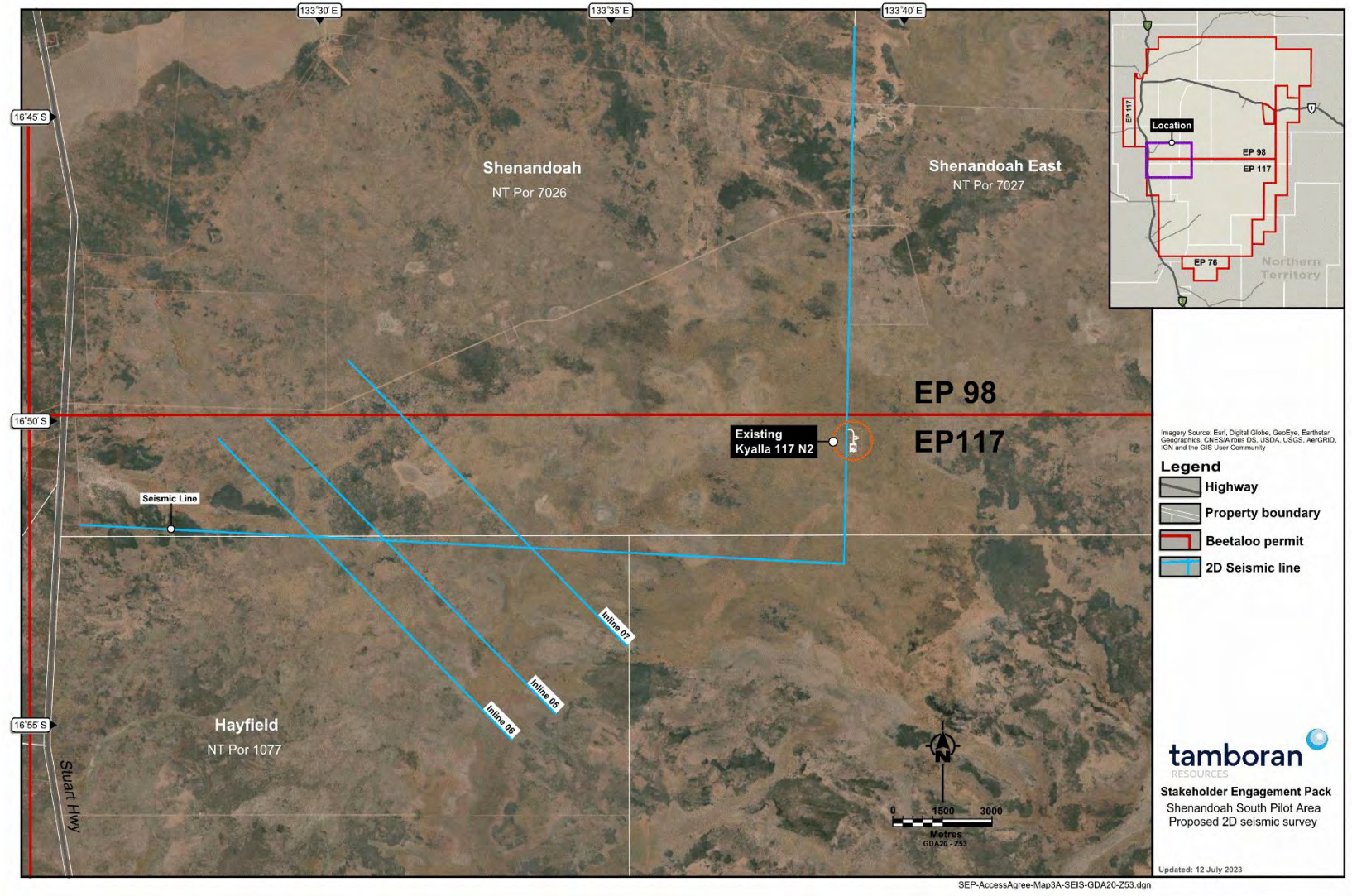
Table 9: Analytes and method for drilling waste assessment

Analyte	Method Code	LOR	Units (on a dry weight basis)
Sampled			
Ag	iMET2SAICP	*0.5*	mg/kg
Al	iMET2SAICP	*10*	mg/kg
As	iMET2SAICP	*1*	mg/kg
B	iMET2SAICP	*5*	mg/kg
Ba	iMET2SAICP	*0.1*	mg/kg
Be	iMET2SAICP	*0.05*	mg/kg
C	(combs)	*0.05*	%
CO3	(combs)	*0.25*	%
Cd	iMET2SAICP	*0.05*	mg/kg
Cl	iCO1SEDA	*5*	mg/kg
Co	iMET2SAICP	*0.1*	mg/kg
Cr	iMET2SAICP	*0.05*	mg/kg
Cu	iMET2SAICP	*0.1*	mg/kg
EC_25C	iEC1SASE	*0.2*	ms/m
F	eF1ST	*50*	mg/kg
H2O_105C	iMOIS1SAGR	*0.1*	%
Hg	iMET2SAMS	*0.02*	mg/kg
Mn	iMET2SAICP	*0.2*	mg/kg
Mo	iMET2SAICP	*0.5*	mg/kg
N	(total)	*0.005*	%
Ni	iMET2SAICP	*1*	mg/kg
P	(totals)	*10*	mg/kg
Pb	iMET2SAICP	*0.5*	mg/kg
Se	iMET2SAICP	*2*	mg/kg
Sr	iMET2SAICP	*0.2*	mg/kg
TIC	(combs)	*0.05*	%
TOC	(combs)	*0.05*	%
V	iMET2SAICP	*0.2*	mg/kg

Analyte	Method Code	*LOR*	Units (on a dry weight basis)
Zn	iMET2SAICP	*5*	mg/kg
pH *	iPH1SASE	*0.1*	
Benzene	eBTEXSoil	*0.5*	mg/kg
Toluene	eBTEXSoil	*0.5*	mg/kg
Ethylbenzene	eBTEXSoil	*0.5*	mg/kg
Xylene	eBTEXSoil	*1*	mg/kg
Total BTEX	eBTEXSoil	*2.5*	mg/kg
TPH C6-C9	eTPHSoils	*25*	mg/kg
TPH C10-C14	eTPHSoils	*50*	mg/kg
TPH C15-C28	eTPHSoils	*100*	mg/kg
TPH C29-C36	eTPHSoils	*100*	mg/kg
Total TPHs	eTPHSoils	*275*	mg/kg
Acenaphthene	ePAH1SOIL	*1*	mg/kg
Acenaphthylene	ePAH1SOIL	*1*	mg/kg
Anthracene	ePAH1SOIL	*1*	mg/kg
Benz(a)anthracene	ePAH1SOIL	*1*	mg/kg
Benzo(a)pyrene	ePAH1SOIL	*1*	mg/kg
Benzo(b+k)fluoranthene	ePAH1SOIL	*1*	mg/kg
Benzo(g,h,i)perylene	ePAH1SOIL	*1*	mg/kg
Chrysene	ePAH1SOIL	*1*	mg/kg
Dibenzo(a,h)anthracene	ePAH1SOIL	*1*	mg/kg
Fluoranthene	ePAH1SOIL	*1*	mg/kg
Fluorene	ePAH1SOIL	*1*	mg/kg
Indeno(1,2,3-cd)pyrene	ePAH1SOIL	*1*	mg/kg
Naphthalene	ePAH1SOIL	*1*	mg/kg
Phenanthrene	ePAH1SOIL	*1*	mg/kg
Pyrene	ePAH1SOIL	*1*	mg/kg
Total PAHs	ePAH1SOIL	*16*	mg/kg
ASLP Extract Analysis			
Ag	iMET1WCMS	*0.001*	mg/L
Al	iMET1WCICP	*0.05*	mg/L
As	iMET1WCMS	*0.001*	mg/L
B	iMET1WCICP	*0.05*	mg/L

Analyte	Method Code	*LOR*	Units (on a dry weight basis)
Ba	iMET1WCICP	*0.002*	mg/L
Be	iMET1WCICP	*0.001*	mg/L
Cd	iMET1WCMS	*0.0001*	mg/L
Cl	iCO1WCDA	*1*	mg/L
Co	iMET1WCICP	*0.005*	mg/L
Cr	iMET1WCICP	*0.001*	mg/L
Cu	iMET1WCMS	*0.001*	mg/L
Hg	iHG1WCVG	*0.0001*	mg/L
Hg	iMET1WCMS	*0.0001*	mg/L
Mn	iMET1WCICP	*0.001*	mg/L
Mo	iMET1WCMS	*0.001*	mg/L
Ni	iMET1WCMS	*0.001*	mg/L
Pb	iMET1WCMS	*0.001*	mg/L
Se	iMET1WCMS	*0.001*	mg/L
Sr	iMET1WCICP	*0.001*	mg/L
V	iMET1WCICP	*0.005*	mg/L
Zn	iMET1WCICP	*0.005*	mg/L
pH_ASLP	iASLP	*0.1*	pH unit
Gross Alpha		0.05	Bq/L
Gross Beta		0.1	Bq/L

Appendix B - Map of seismic lines



Appendix C Groundwater monitoring analyte list (sourced form Preliminary guideline: Groundwater monitoring bores for Exploration petroleum well in the Beetaloo Sub Basin (https://denr.nt.gov.au/__data/assets/pdf_file/0009/618957/Preliminary-Guideline-Petroleum-Well-Water-Quality-Monitoring.pdf)

Table 2 – Required analytes

General	Anions	Cations and Metals		Petroleum
pH	**Chloride**	Calcium	Arsenic	TRH
Electrical conductivity*	Fluoride	Chromium	**Barium**	PAH Suite
Total Dissolved Solids	Sulphate	Copper	Boron	BTEX
Total Suspended Solids	Nitrate	Iron	Cadmium	Diss. Methane
Alkalinity	Nitrite	Lead	Lithium	Diss. Ethane
Gross Alpha		Magnesium	Selenium	Diss. Propane
Gross Beta		Manganese	Silica	
Water level**		Mercury	**Strontium**	
Groundwater pressure***		Potassium	Sodium	
		Silver	Zinc	

*Recommendation 7.11 requires that electrical conductivity (E.C.) should be measured in real-time as an indicator providing 'early warning' of contamination, with the results telemetered from the site to the regulator and made available to the public. It is recognised by DENR that this may be difficult to implement in the first stages of exploration, but proponents should provide a plan and timetable to meet this requirement, preferable before hydraulic fracturing occurs.

**A survey benchmark relative to Australian Height Datum (AHD) should be established at each well pad monitoring bore, accurate to ±10 cm or better, to accurately determine water table elevation.

***This indicator has been suggested by industry and collection of this data is encouraged in order to test validity and applicability.

Appendix D - Predicted drawdown curves.

Figure 4 Predicted drawdown at closest bore – geometric mean transmissivity

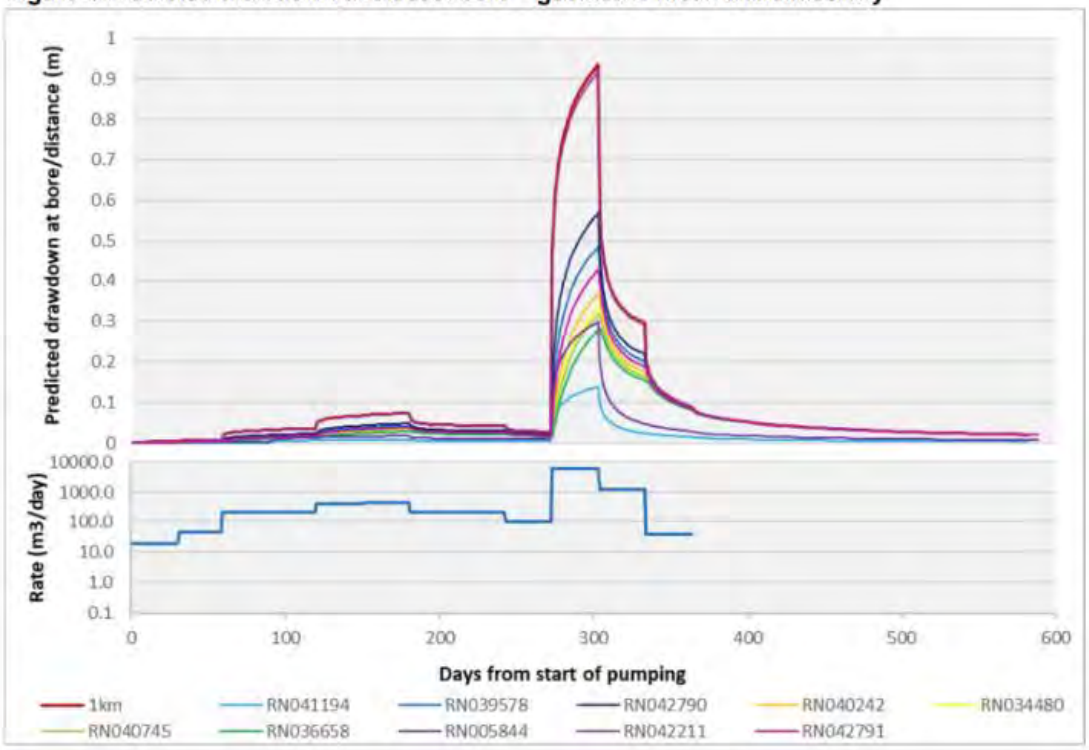
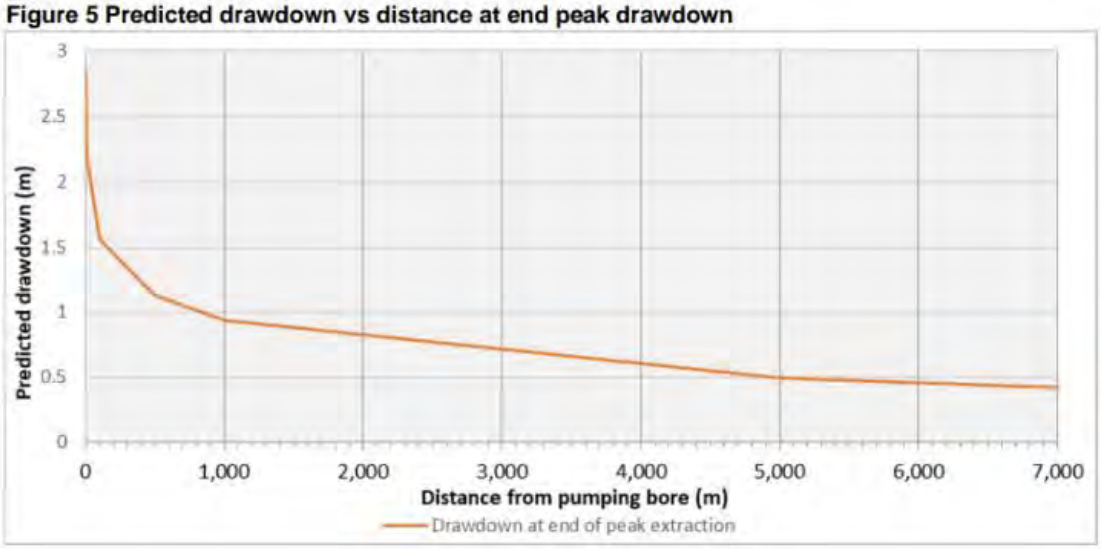
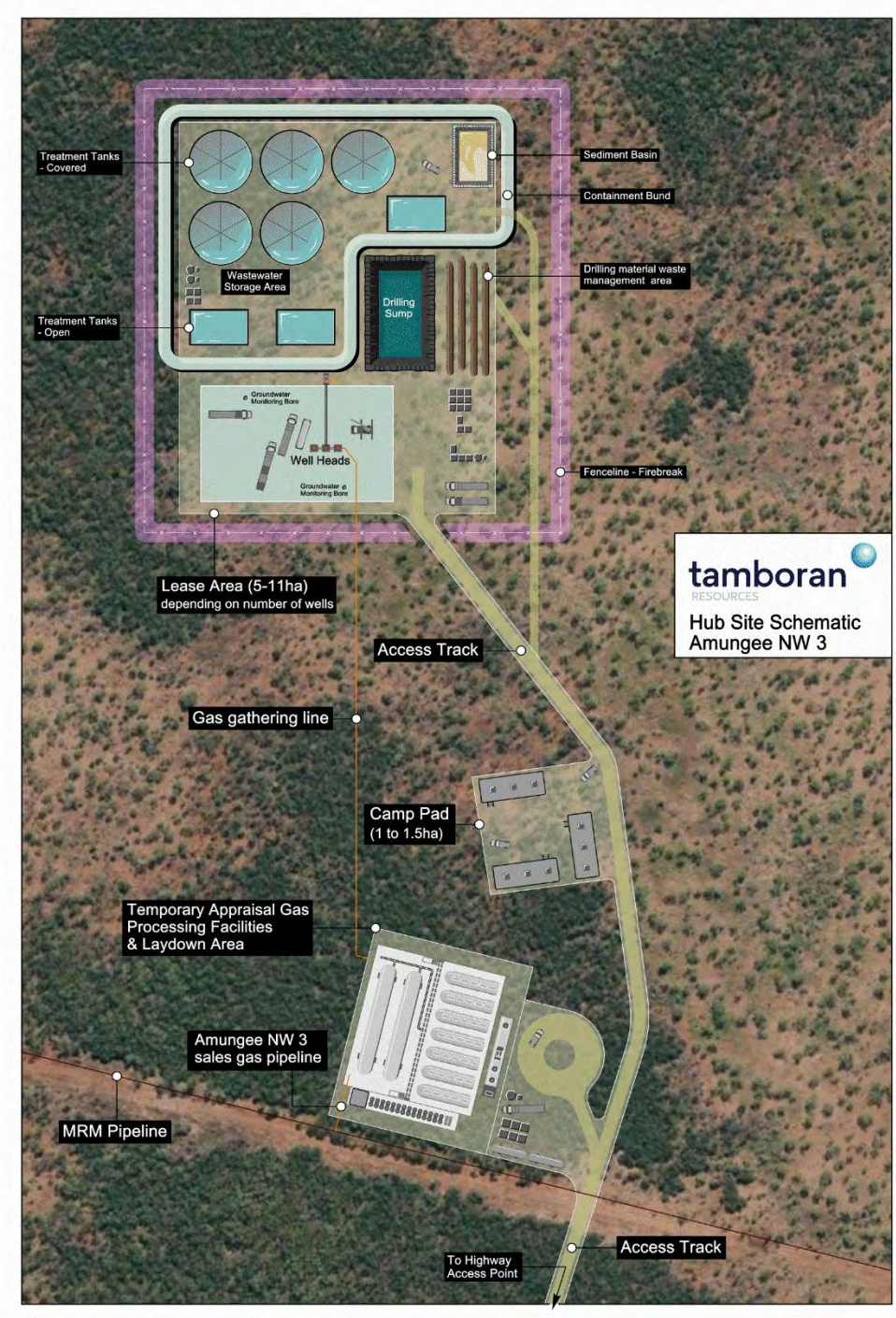


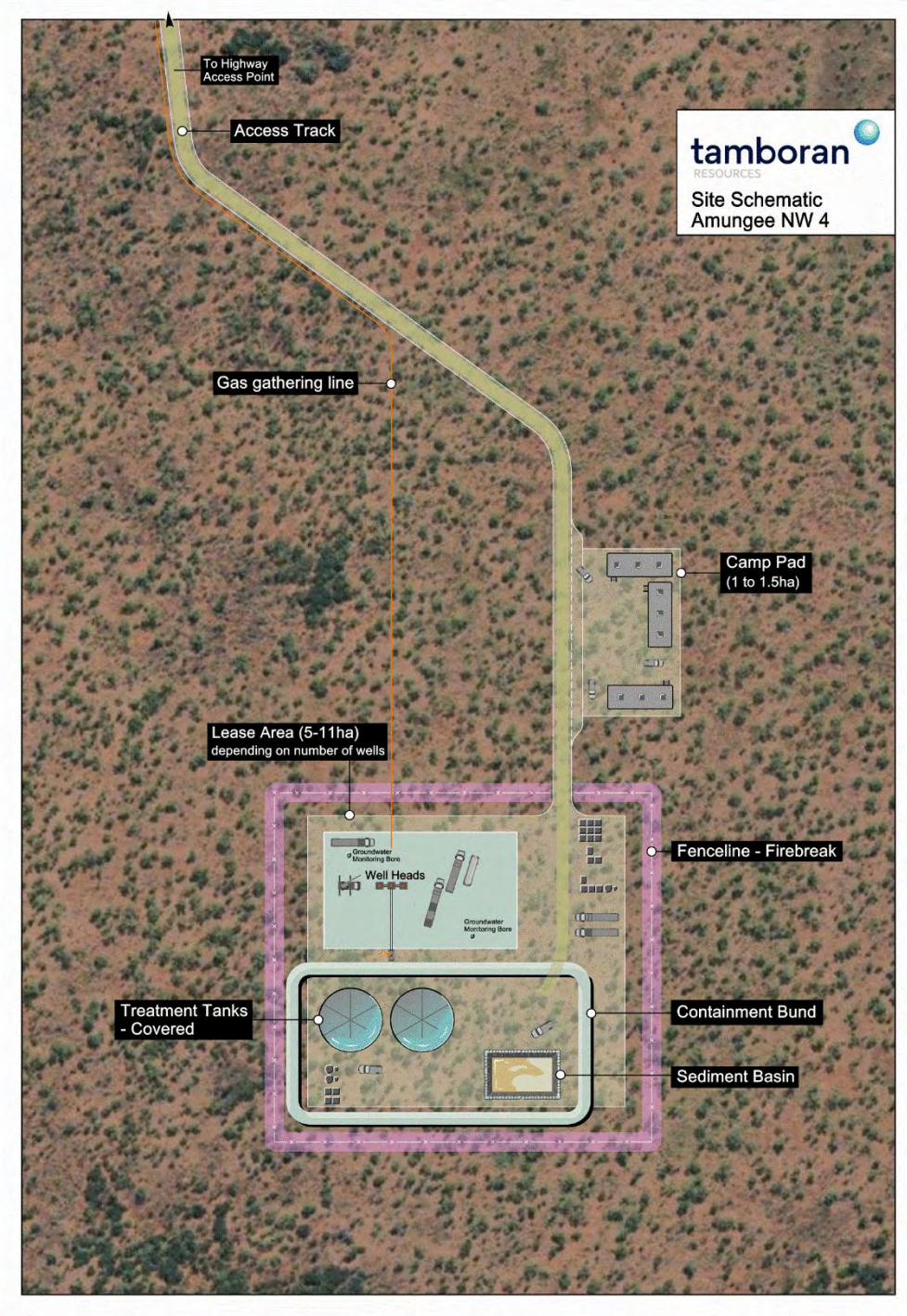
Figure 5 Predicted drawdown vs distance at end peak drawdown



Appendix E Example of a hub versus standard lease pad

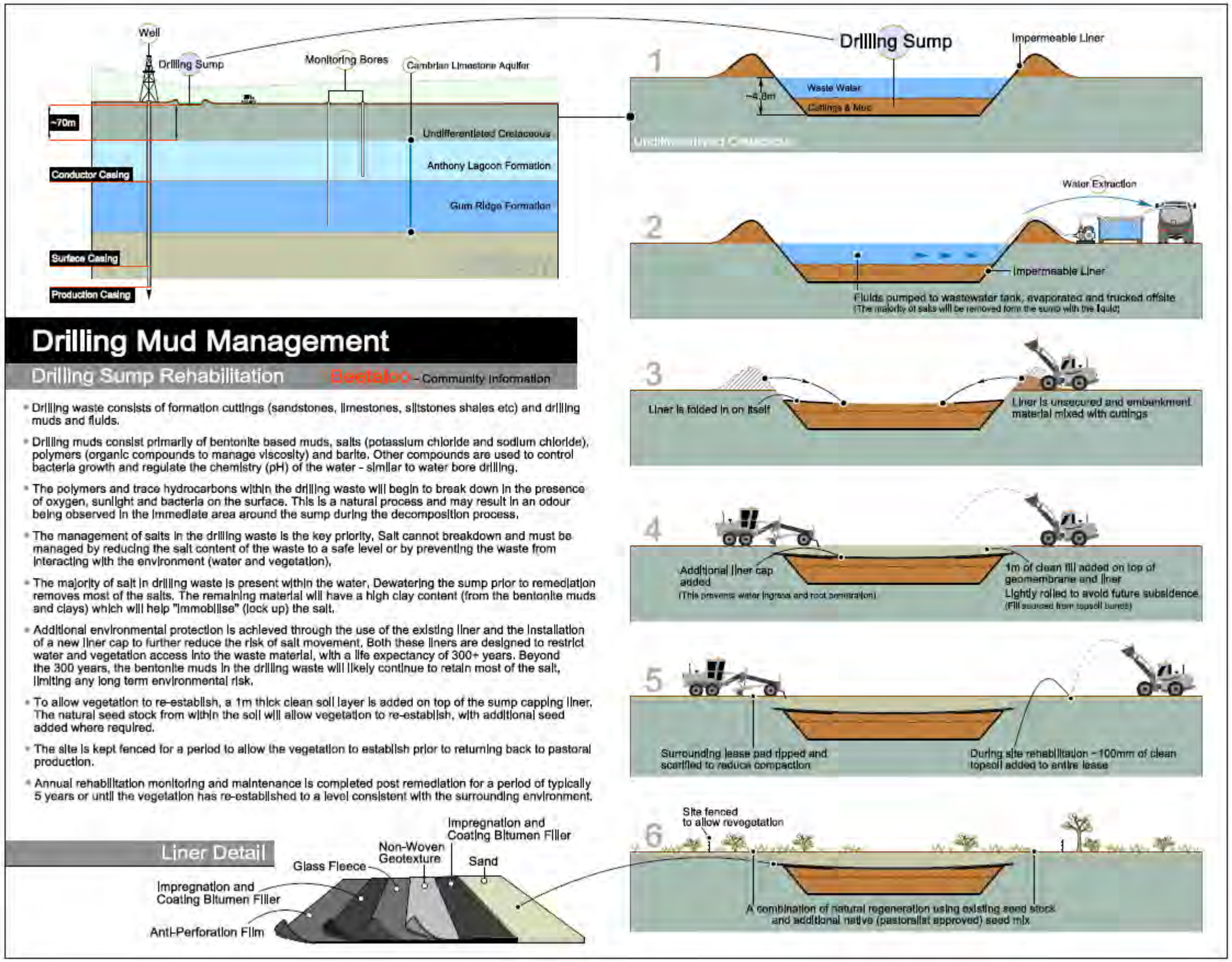


A conceptual schematic of a hub showing an expanded wastewater storage area to host multiple wastewater storage tanks used to store flowback. The hub will be typically ~ 10 hectares. A drilling waste management area will be constructed with a sump and material blended with organic material and composted onsite to generate usable fill for rehabilitation- such as backfilling gravel pit voids.



A concept utilisation of a smaller hub, which has a smaller area (<5hectares) as a reduced number of tanks is required. Due to the volume of water needing support stimulations, some tankage will still be required.

Appendix F Mix-bury-cover



Tasks	Start date	End date	YEAR 1 (1023-24)												YEAR 2 (2024-25)					
			Y1Q1			Y1Q2			Y1Q3			Y1Q4			Y2Q1			Y2Q2		
			Jul 23	Aug 23	Sep 23	Oct 23	Nov 23	Dec 23	Jan 24	Feb 24	Mar 24	Apr 24	May 24	Jun 24	Jul 24	Aug 24	Sep 24	Oct 24	Nov 24	Dec 24
Kyalla 117 N2	**1/08/23**	**29/01/24**																		
E&A well drilling Kyalla 117 N2-Shenandoah 1H*, incl mob/demob	1/08/23	15/09/23																		
E&A well stimulation Kyalla 117 N2-Shenandoah 1H*	6/10/23	21/10/23																		
E&A well testing Kyalla 117 N2-Shenandoah 1H**	21/10/23	29/01/24																		
Amungee NW 3H	**29/09/23**	**7/08/24**																		
E&A well drilling SS-A 1H incl mob/demob	29/09/23	13/11/23																		
E&A well stimulation SS-A 1H	15/03/24	29/04/24																		
E&A well testing/flaring SS-A 1H	29/04/24	7/08/24																		

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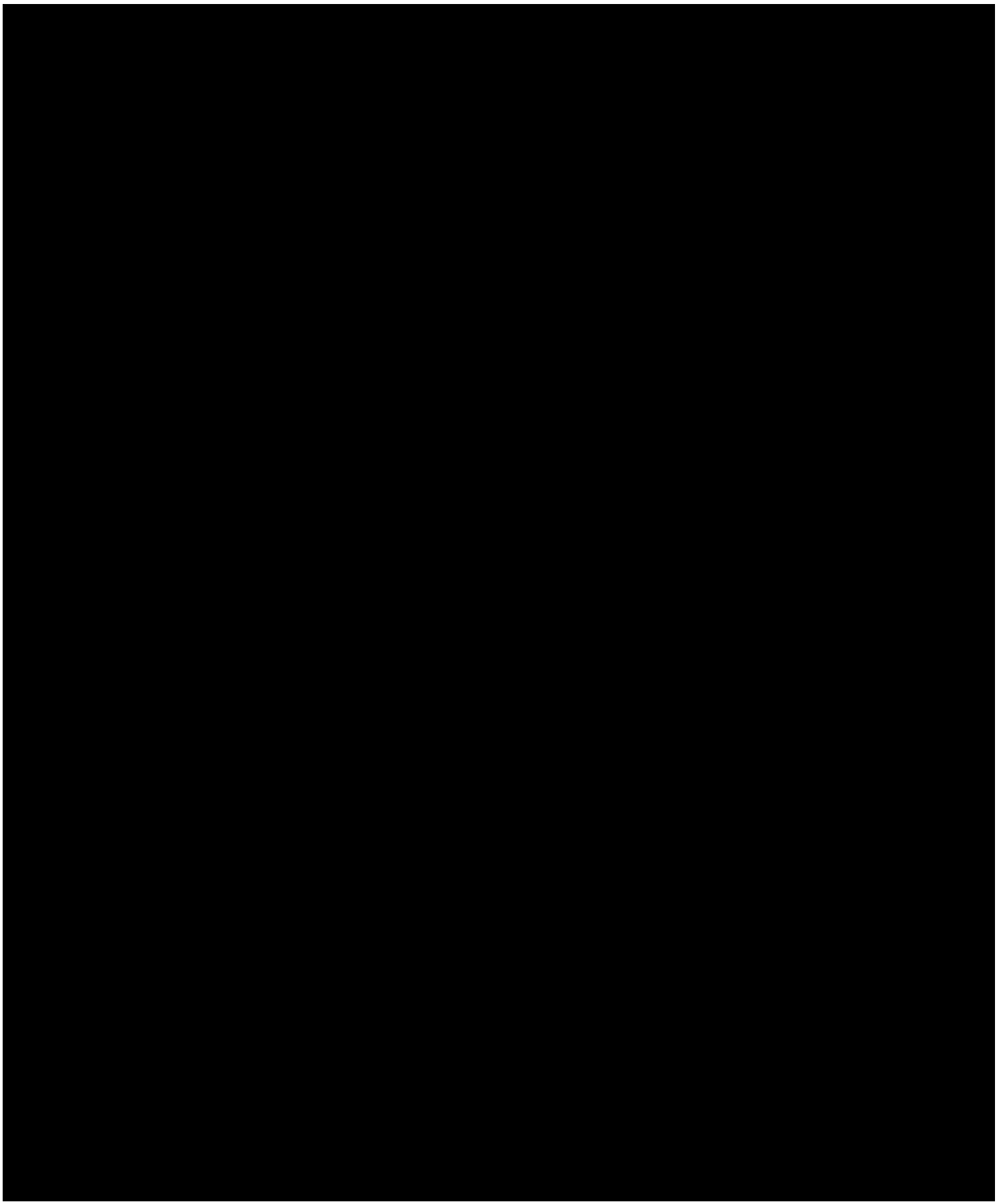

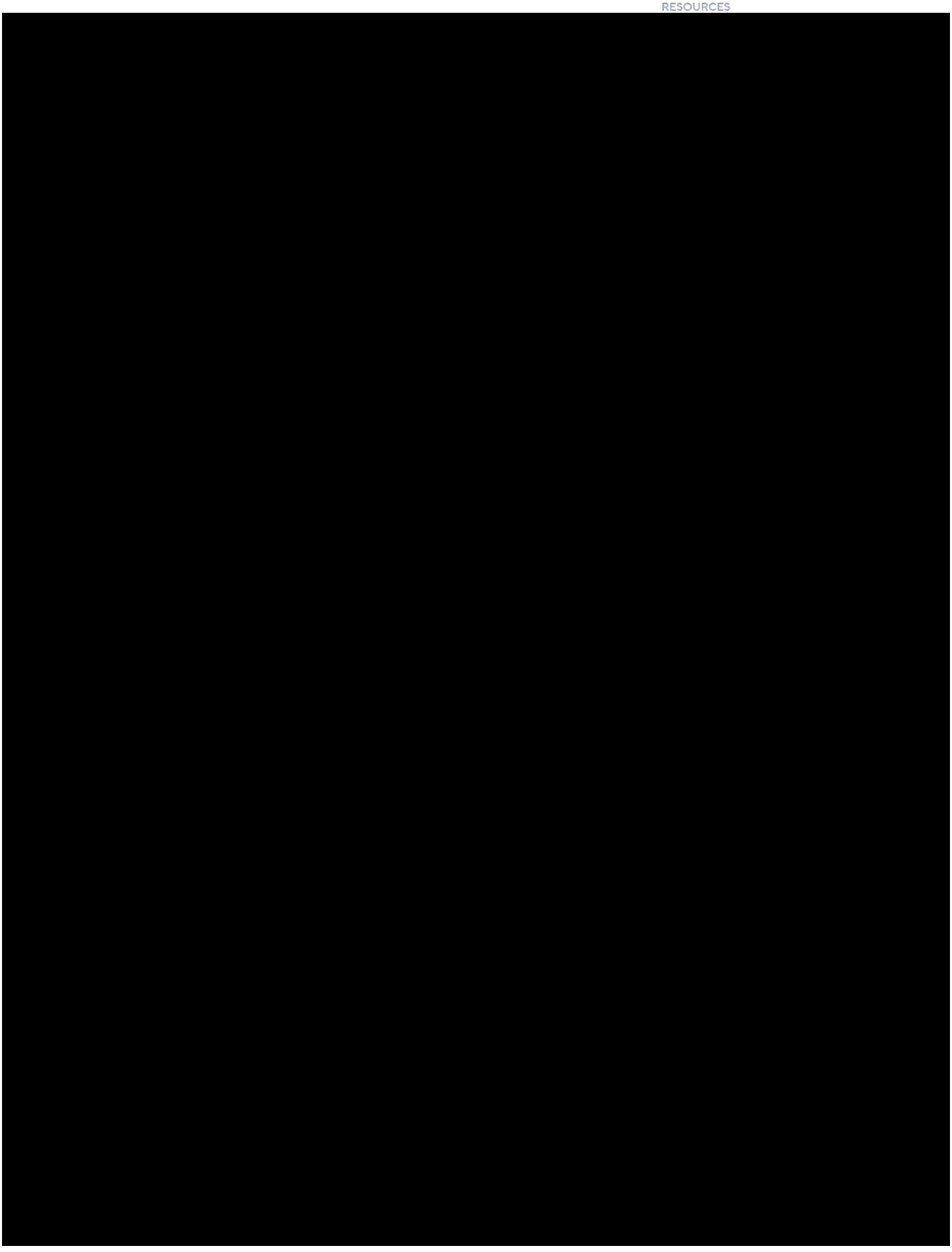

GPO Box 4025, Darwin NT 0801 Australia

Appendix N.1.2 21 230906 Letter NLC to Tamboran - Beetaloo ILUA negotiations - next steps

From:	Emily Beresford-Cane
To:	Tamboran Contact
Subject:	Fwd: Beetaloo Basin ILUA negotiations - next steps [NLC-NLC.FID28535]
Date:	Wednesday, 6 September 2023 7:20:11 PM
Attachments:	image001.png 230906 Letter NLC to Tamboran - Beetaloo ILUA negotiations - next steps.pdf

Begin forwarded message:

From: [redacted]
Subject: Beetaloo Basin ILUA negotiations - next steps [NLC-NLC.FID28535]
Date: 6 September 2023 at 5:51:31 pm AEST
To: Emily Beresford-Cane [redacted]
Cc: [redacted]

Good afternoon Emily

Please find attached our letter to you dated 6 September 2023.

Regards

[redacted]
Senior Lawyer (Resources & Energy)
Northern Land Council

NORTHERN LAND COUNCIL
Our Land, Our Sea, Our Life

[redacted] | Website: www.nlc.org.au

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Our Land, Our Sea, Our Life

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45 Mitchell Street Darwin NT 0800
P: 08 8920 5100 • F: 08 8945 2633
Freecall: 1800 645 299
www.nlc.org.au
ABN 56 327 515 336

6 September 2023

Our [redacted]

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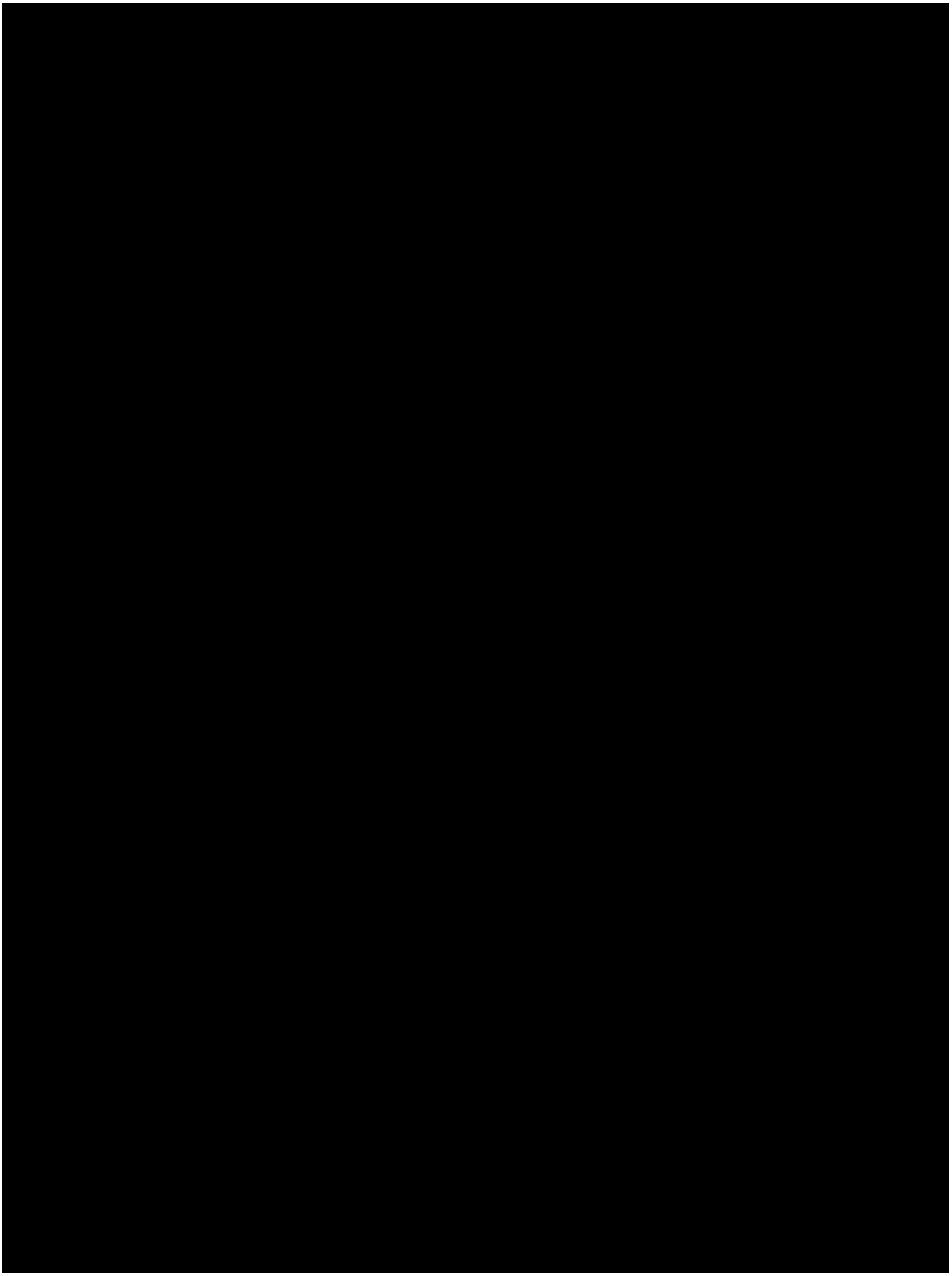
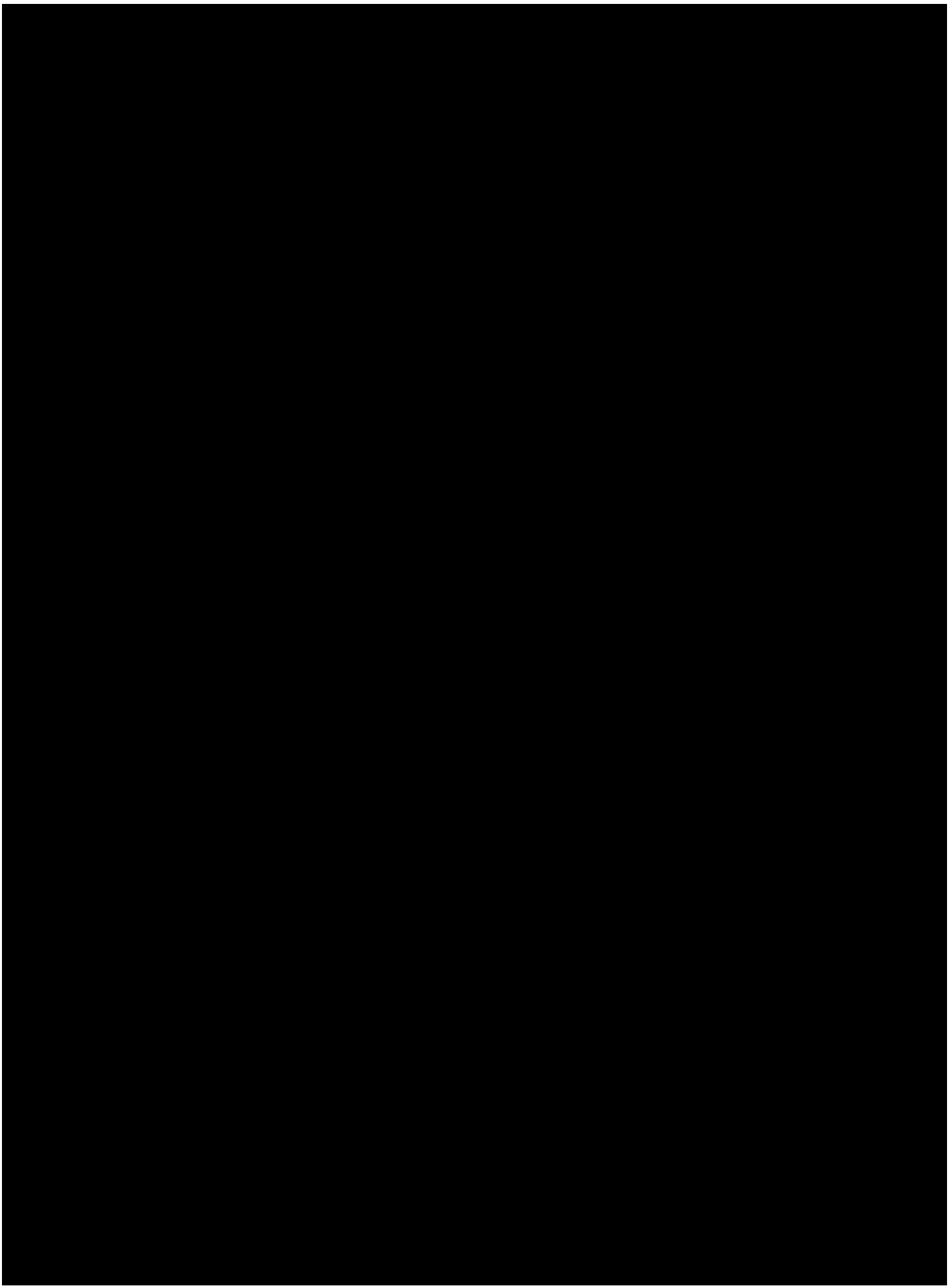
[redacted]

Katherine	Jabiru	Nhulunbuy	Borroloola	Ngukurr	Tennant Creek	Timber Creek	Wadeye
P.O. Box 396	P.O. Box 18	P.O. Box 820	P.O. Box 453	P.M.B. 85 via	P.O. Box 55	43 Wilson St	Lot 788 Kanarlda St
Katherine NT 0851	Jabiru NT 0886	Nhulunbuy NT 0881	Borroloola NT 0854	Katherine NT 0851	Tennant Creek NT 0861	Timber Creek NT 0852	Wadeye NT 0822
P: (08) 8971 9899	P: (08) 8938 3000	P: (08) 8986 8500	P: (08) 8975 8848	P: (08) 8975 4755	P: (08) 8962 1884	P: (08) 8975 0789	P: 0439 830 435
F: (08) 8972 2190	F: (08) 8979 2650	F: (08) 8987 1334	F: (08) 8975 8745	F: (08) 8975 4601	F: (08) 8962 1636	F: (08) 8975 0664	

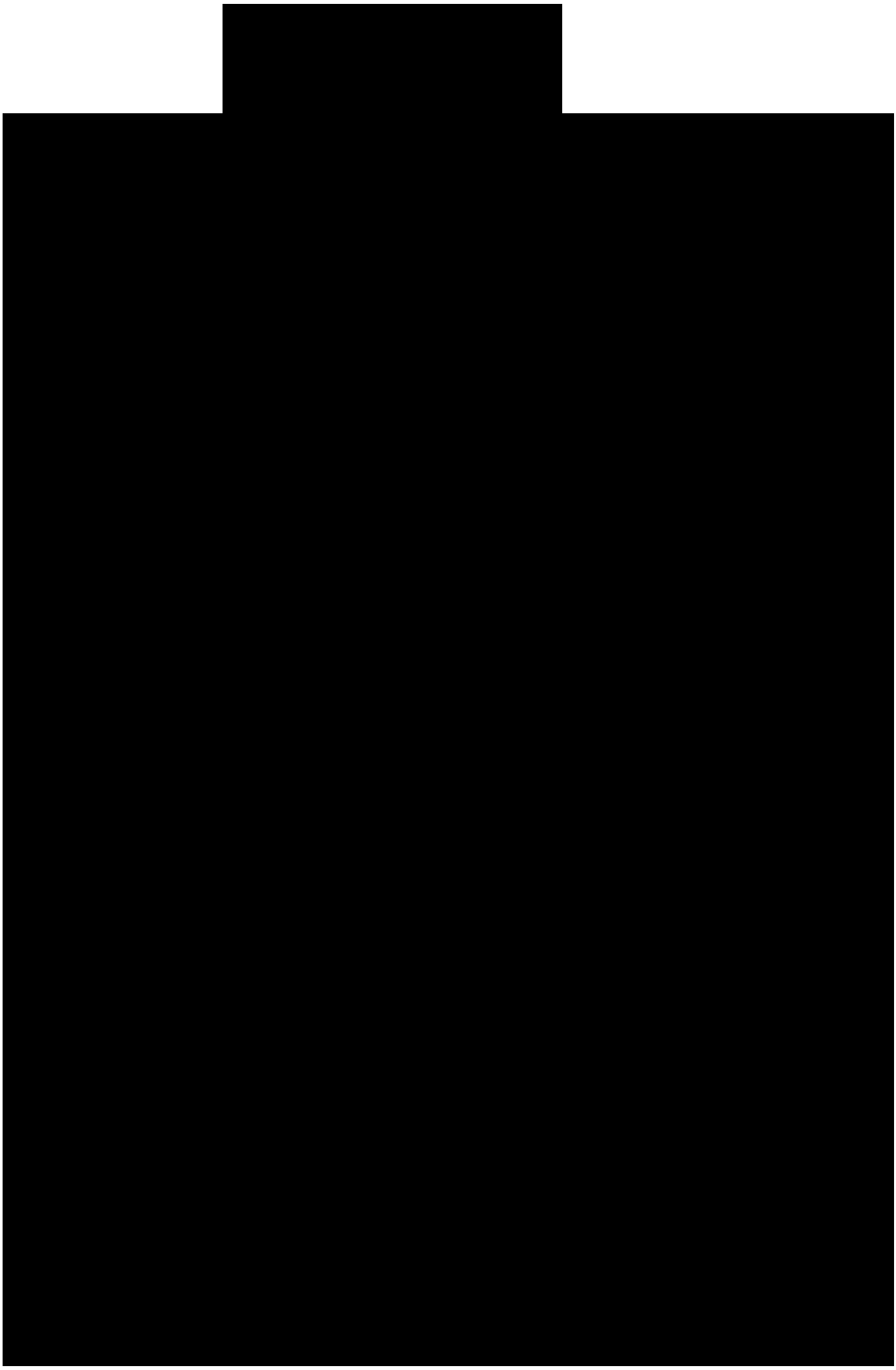


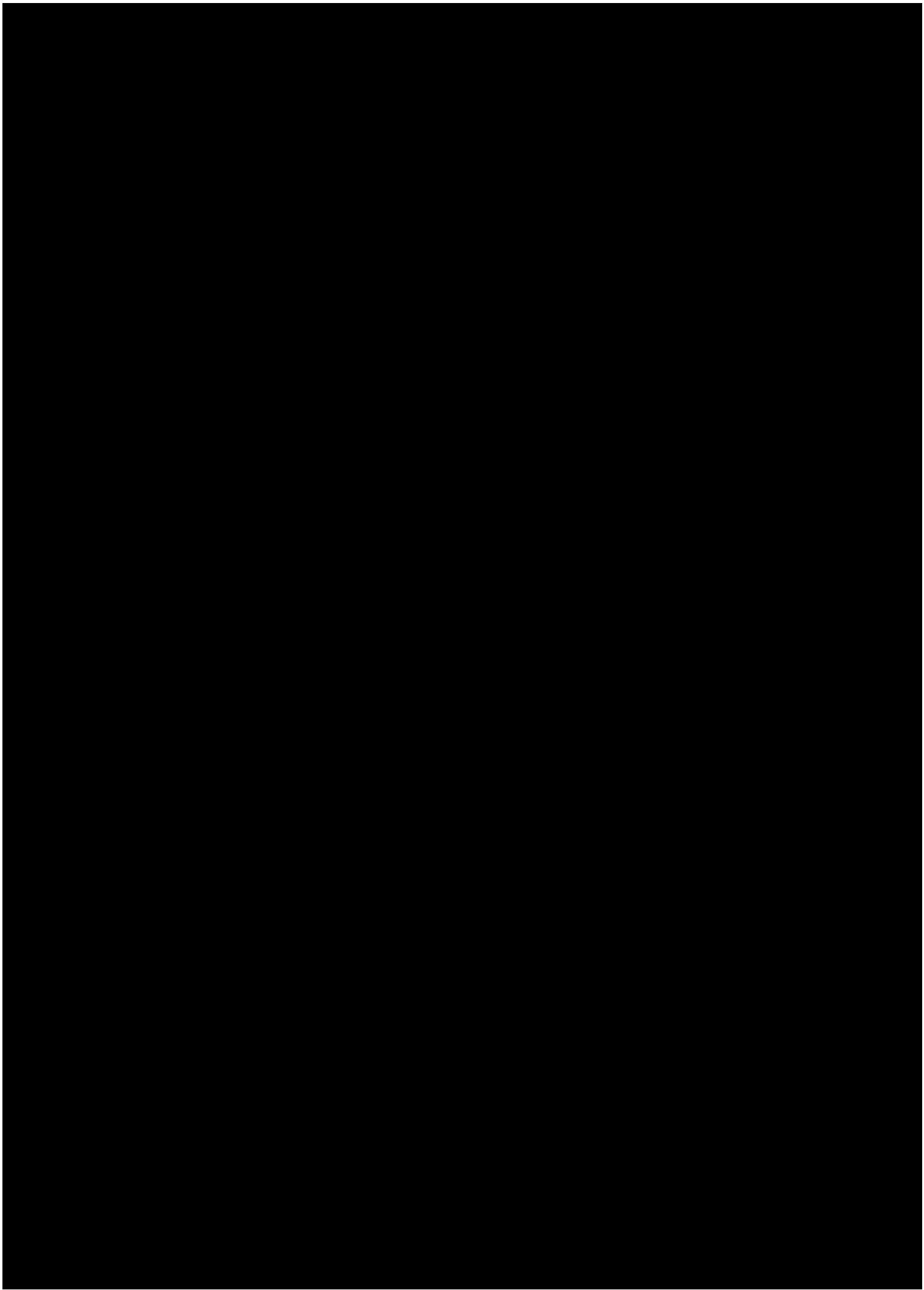


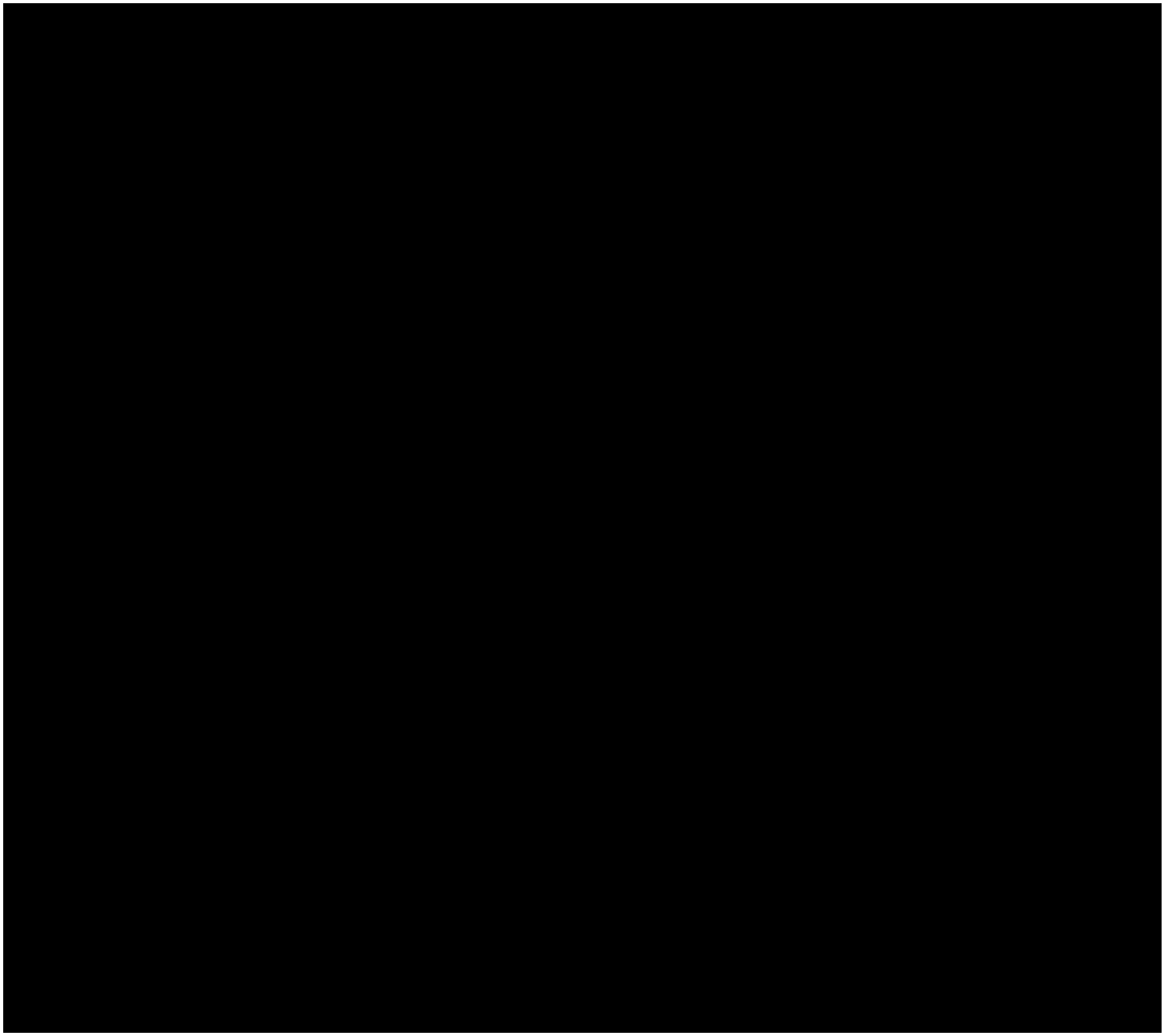
[redacted]

Yours sincerely,

[redacted]
Senior Lawyer – Resources & Energy







Appendix N.1.2 22 230921 Email response

From: Matt Kernke
Sent: Thursday, 21 September 2023 11:05 AM
To: Jeremy Beckett
Cc: Emily Beresford-Cane; Linda Pugh; Tamboran Contact
Subject: RE: GIS meeting follow up

Hi [redacted]

I hope the below answers the questions. The modelling we provide in our application is just supporting evidence, with the NTG running their own model to assess independently. We supply this for due diligence/ stakeholder purposes to demonstrate we consider these constraints when submitting our applications.

Talk soon,
Matt

From: [redacted]
Sent: Thursday, September 21, 2023 10:37 AM
To: Matt Kernke [redacted]
Cc: Emily Beresford-Cane [redacted]
Subject: RE: GIS meeting follow up

Good morning Matt,

Thanks again for giving us the opportunity to provide comment. Please see comments below in red for your review and response.

Also, could you please confirm the following:

- Values presented in Table 4.2. The discrepancy between mean and median in the bottom two rows are very large. If the values are correct can you provide an explanation and context. The limestone units are essentially laterally continuous across the different basins- though recharge rates and pathways differ. The difference in the average and median highlights that there is quite a large degree in variability in the amount of rainfall from wet seasons within the different basins. Mataranka and Flora TLA are in the Daly Basin which is further North and has a mor reliable wet season than the southern basins of the Wiso and Georgina Basins. In the Mataranka and Flora TLA, this is reflected by the lower degree of difference between the average and median. In the Southern Basins, you may have very poor wet seasons which would result in limited recharge and conversely very very large wet seasons which result in extremely high levels of recharge.
- Rather than refer us to data we would also like a simple answer to our question on how long will they pump and after cessation of pumping will the groundwater return to the predisturbance level. We expect to be extracting water under this licence for 3 years. Pumping will not be continuous or at just 1 location. Pumping will occur at various times and across the basin, with sites up to 60km a part. - with pumping not continuous. The model assumes essentially continuous pumping at different rates at one location. The model also uses a geometric mean transmissivity, which is lower than anticipated transmissivity based on observed rates at our monitoring/extraction bores (section 2 of the application discusses this- i..e how industry bores are required to penetrates the entire Gum Ridge Sequence versus available data used by the NTG only penetrates a fraction of the formation). The modelled return to pre-pumped water levels is ~ 100 days. Base don't eh transmissivity being higher, the take will be from multiple bores located several km's a part- the actual return to pre-pumped level is anticipated to significantly less than this.

Kind regards,

[redacted]

Senior Project Officer
Resources & Energy Branch
Northern Land Council

From: Matt Kernke [redacted]
Sent: Wednesday, 20 September 2023 9:22 AM
To: Jeremy Beckett [redacted]
Cc: [redacted]
Subject: RE: GIS meeting follow up

Hi [redacted]

Just following up on the below email to see if the NLC had any follow up questions? We are intending to submit this WEL within the next week.

Kind Regards
Matt

From: Matt Kernke
Sent: Tuesday, September 5, 2023 4:48 PM
To: [redacted]
Cc: [redacted]
Subject: RE: GIS meeting follow up

Hi [redacted]

Thank you for taking the time in reviewing Tamboran's Water Extraction Licence (WEL). The underlying groundwater systems have been extensively studied of recent, largely as a results of DEPWS ongoing resource characterisation program and NT Hydraulic Fracturing Inquiry recommendations. These data sources have underpinned our application and will also form the basis for the licence impact assessment from DEPWS. Once submitted, DEPWs will assess our application independently using a calibrated groundwater model based on real monitoring results and the known properties of the target Cambrian Limestone Aquifers. All proposed groundwater take is added to the model, to ensure they do not impact on the sustainability of the unit and known dependent users (such as environment an, social and cultural). These information sources are provide below, along with the links where relevant:

- Strategic Regional Environment Baseline Assessment Report (Regional report | Department of Environment, Parks and Water Security),
- the Georgina Wiso Water Allocation Plan (available here: Georgina Wiso water allocation plan | NT.GOV.AU)
- Impact assessment for the Beetaloo GBA region - Geological and Bioregional Assessment: Stage 3 Synthesis report (Impact assessment for the Beetaloo GBA region (stage 3) | Bioregional Assessments), specifically section 4.2

Additional information, or specific section of reports are also provided below:

Aquifer recharge

- **Provide rate of recharge for target aquifer.**
- **Provide all other water balance parameters for the target aquifers.**
- **Provide information/ data relevant to what your rate of recharge is founded upon.**

The information requested forms a key part of the Aquifer characteristics which have been utilised to develop the Georgina Wiso Water Allocation Plan (available here: Georgina Wiso water allocation plan | NT.GOV.AU) .

Information has also been compiled as a part of the Strategic Regional Environment Baseline Assessment Report (Regional report | Department of Environment, Parks and Water Security), specifically section 4 . Estimates of annual recharge are provided in Table 4.2 and discussed in detail in section 4.3.

Table 4-2. Annual wet season recharge estimates for the Beetaloo Sub-basin WAP sub-areas from the DR2 2020 model (model run to 1 November 2021).

Water allocation planning management area	Wet season average (ML/year)	Wet season median (ML/year)
Mataranka TLA	319,000	211,000
Flora TLA	261,000	119,000
Wiso Basin	48,000	4,000
Georgina Basin	608,000	600

Additional information is available within the following:

- CloudGMS (2020) Upgrade of the Coupled Model of the Cambrian Limestone Aquifer and the Roper River Systems. Version 1.0 October 2020. WRD Technical Report 57/2020. Prepared for the Department of Environment, Pars and Water Security.
- Tickell, S. and Bruwer, Q. (2017) Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek. Water Resources Division. Report 17/2017 (Version 2, April 2019). Department of Environment and Natural Resources
- Crosby R., and Rachakonda, P.K. (2020) Constraining probabilistic chloride mass-balance recharge estimates using baseflow and remotely sensed evapotranspiration: the Cambrian Limestone Aquifer in northern Australia. Hydrogeology Journal (2021) 29:1399–1419
- DEPWS (2022) Regional Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. DEPWS Technical Report 41/2022. Department of Environment, Parks and Water Security, Northern Territory Government. Berrimah, Northern Territory.

Provide map showing the location of each proposed extraction bore, the bore depth and target aquifer and the proposed annual volume take from each. Maps showing the proposed locations were included in the application documents provided. The maximum estimated monthly water extraction rates were tabulated and shown graphically. It is anticipated that new sites will be added to the (Water Extraction Licence) WEL progressively. The location of these sites has not yet been defined, but will be added through engagement with the NLC as part of the annual work program updates and sacred site clearance requests. Where a new bore is proposed to be included in a WEL, Tamboran will submit to the NTG a WEL amendment where the impact of that water extraction point will be specifically assessed.

- **Provide map showing the geographic extent of the cone of depression extending from each of the extraction bores**. A distance drawdown graph was provided. The modelling performed assumes radial flow. The distances are too small to show sensibly on a map.

- **Provide information on the total length of time that water will be extracted from the aquifers and the timeframe for recovery**. The assumed pumping rates, predicted drawdown and recovery at the closest registered bore to each proposed water extraction site was provided.

Provide copies of all baseline assessments of regional water holes, creeks and springs (standing water levels, flow rates/volumes etc by season, analytes and bacteria tested for). (Noting Tamboran's comment that "Water extraction to support Tamboran's exploration activities will not impact features such as water holes, creeks or Springs").

NR Maps identifies no springs within the Tamboran EPs. The closest mapped springs are where the shallow water table is mapped along the Cox River to the northwest of EP98. [Are we able to idenfity these springs – the TOs may want adequate baselining of these along the lines recommended by Dr Mudd.]

The depth to the regional water table in the CLA aquifer ranges from 80 to 120 mbgl in the vicinities of the planned exploration sites. This water level is consistent sufficient separation distance between the target formation and surficial sediments.

Baseline information requested is included in the DEPWS (2022) Regional Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. DEPWS Technical Report 41/2022. Department of Environment, Parks and Water Security, Northern Territory Government. Berrimah, Northern Territory. Section 4.3 discusses the hydrogeological setting of the region and provides a good summative illustration highlighting the deeper CLA units are hydrologically separate form the surface sediment sin figure 4-6. This can be accessed here: (Regional report | Department of Environment, Parks and Water Security).

This is what the cited text says (pp 63 to 65):

The CLA is potentially connected with many of the other hydrostratigraphic units (HSUs) recognised in the region and, based on current mapping, a number of general configurations are possible, both at the top and bottom of the CLA.

….

Evidence of potential inter-aquifer (e.g. between the CLA and deeper aquifers) and intra-aquifer (e.g. between the upper and lower units of the CLA) connectivity has also been provided by the environmental tracer investigations and reinterpretation of seismic surveys during the GBA and GISERA programs, and at a small number of sites across the wider Cambrian limestone basins (Daly, Wiso and Georgina) using pumping tests that observe pressure changes in multiple aquifers.

….

However, the faulting that is responsible for the orientation of surface drainage, as well as for the springs at Hot Spring Valley (not part of the CLA), is likely to be deep-rooted and may provide a connection between the Beetaloo Sub-basin and the surface.

The text indicates there has been only one actual field assessment (where an intervening layer of basalt was present) which supports the view that there is little to no connection between hydrostratigraphic units.

We would want an expert to review the SREBA basline information re regional water holes, creeks and springs and advise whether this is adequate. The reference to potential connection between *the Beetaloo Sub-basin and the surface* is very concerning. I think we will need expert advice about this also.

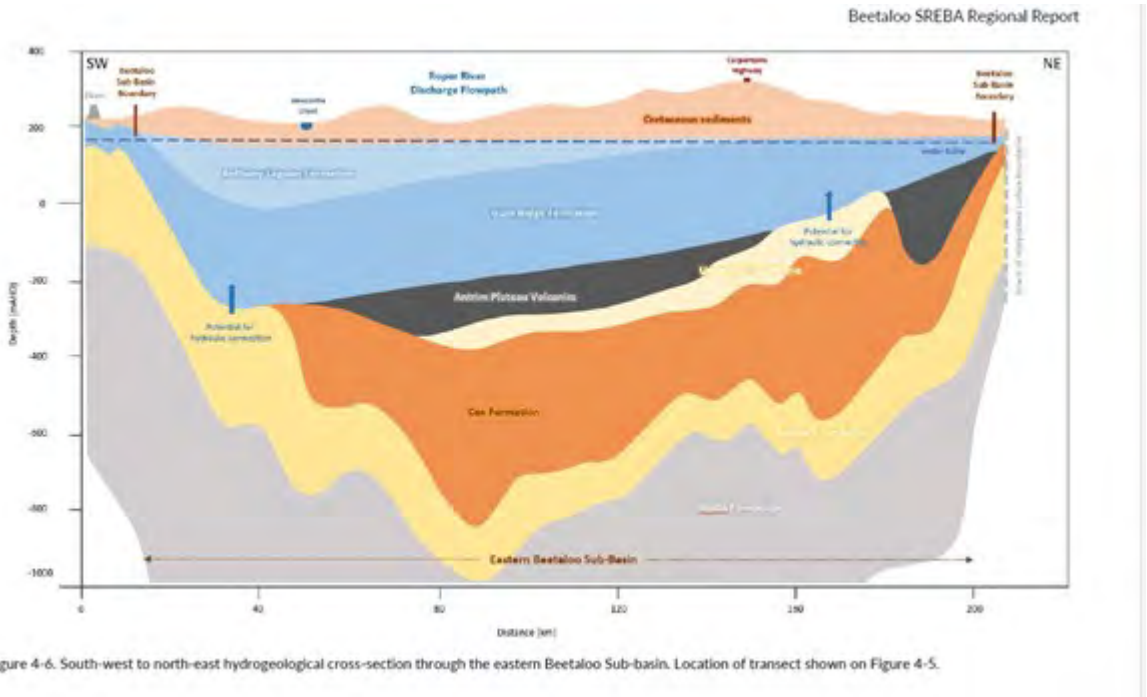


Figure 4-6. South-west to north-east hydrogeological cross-section through the eastern Beetaloo Sub-basin. Location of transect shown on Figure 4-5.

Provide copies of all studies of interconnectivity between surface zones (including seasonally saturated surficial sediments) and the CLA (Noting Tamboran's comment that "The surficial sediments are hydraulically disconnected from the CLA").

Baseline information requested is included in the DEPWS (2022) Regional Report: Strategic Regional Environmental and Baseline Assessment for the Beetaloo Sub-basin. DEPWS Technical Report 41/2022. Department of Environment, Parks and Water Security, Northern Territory Government. Berrimah, Northern Territory. This includes comprehensive information on the hydrogeology and surface hydrology of the Beetaloo sub-basin. Information specific to linkage to surface water bodies of the Newcastle creek is provided in section 4.2. The separation distance between the CLA aquifers (80-120mbgl) is the main fact utilised to highlight these units are not connected. [I am not persuaded that separation distance alone is a basis to conclude no connection – a similar proposition was comprehensively demolished regarding the Condamine aquifer in the Cecil Plains region in QLD.] This can be accessed here: (Regional report | Department of Environment, Parks and Water Security).

Please let me know if you require any further information.

Kind Regards
Matt

From: [redacted]
Sent: Monday, September 4, 2023 2:40 PM
To: Matt Kernke [redacted]
Cc: [redacted]
Subject: RE: GIS meeting follow up

Good afternoon Matt & Emily,

Thanks for giving us the opportunity to review your Water License supporting info for the application. We've had a review internally and have the following comments/ queries;

- Aquifer recharge
  - Provide rate of recharge for target aquifer.
  - Provide all other water balance parameters for the target aquifers.
  - Provide information/ data relevant to what your rate of recharge is founded upon.
- Provide map showing the location of each proposed extraction bore, the bore depth and target aquifer and the proposed annual volume take from each.
- Provide map showing the geographic extent of the cone of depression extending from each of the extraction bores.
- Provide information on the total length of time that water will be extracted from the aquifers and the timeframe for recovery.
- Provide copies of all baseline assessments of regional water holes, creeks and springs (standing water levels, flow rates/volumes etc by season, analytes and bacteria tested for). (Noting Tamboran's comment that "Water extraction to support Tamboran's exploration activities will not impact features such as water holes, creeks or Springs").
- Provide copies of all studies of interconnectivity between surface zones (including seasonally saturated surficial sediments) and the CLA (Noting Tamboran's comment that "The surficial sediments are hydraulically disconnected from the CLA").

Kind regards,

[redacted]
Senior Project Officer
Resources & Energy Branch
Northern Land Council

From: Matt Kernke <m[redacted]
Sent: Wednesday, 9 August 2023 4:19 PM
To: Jeremy Beckett [redacted]
Subject: FW: GIS meeting follow up

From: Emily Beresford-Cane [redacted]
Sent: Friday, June 30, 2023 3:33 PM
To: [redacted]
Cc: [redacted]
Subject: GIS meeting follow up

Hi Jeremy

Please find attached Water Extraction Licence supporting information and AAPA information (for Walter).

Please let Matt know if you have any questions re the attached. We will send through the GIS files separately - and Stuart is welcome to connect directly with matt re GIS queries for efficiency.

Thanks

Emily

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Appendix N.1.2 23 230927 Email response to NLC letter

From: Emily Beresford-Cane
Sent: Wednesday, 27 September 2023 2:34 PM
To: [redacted]
Cc: [redacted]
Subject: Beetaloo Basin ILUA negotiations - next steps
Attachments: Tamboran-NLC Correspondence 27.09.23.pdf

Dear [redacted]

Please find attached correspondence from Tamboran in relation to the NLC's letter of 6 September 2023.

I look forward to our meeting on Friday, and please don't hesitate to call if you have any questions regarding the attached.

Kind regards

Emily

27 September 2023

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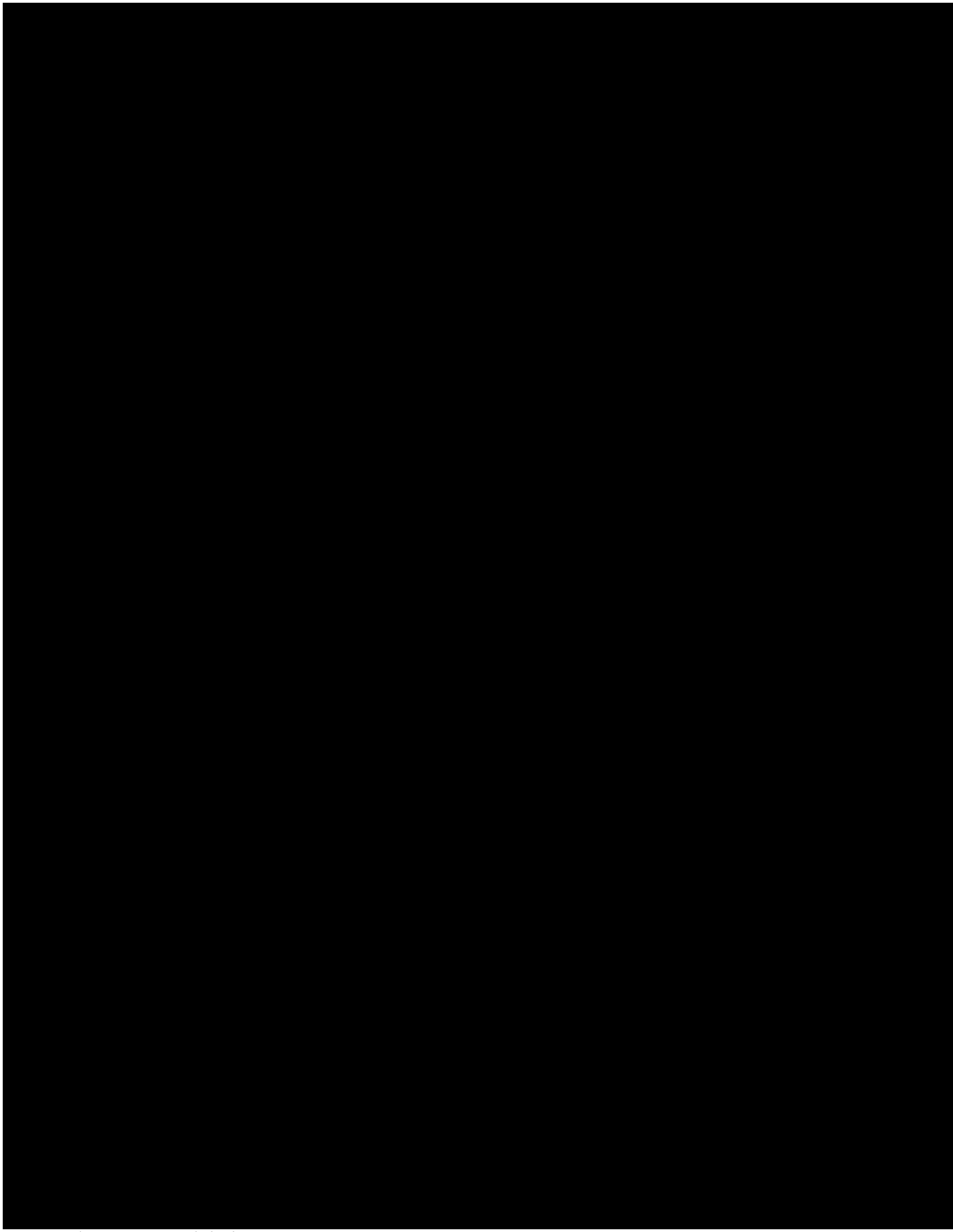
[redacted]



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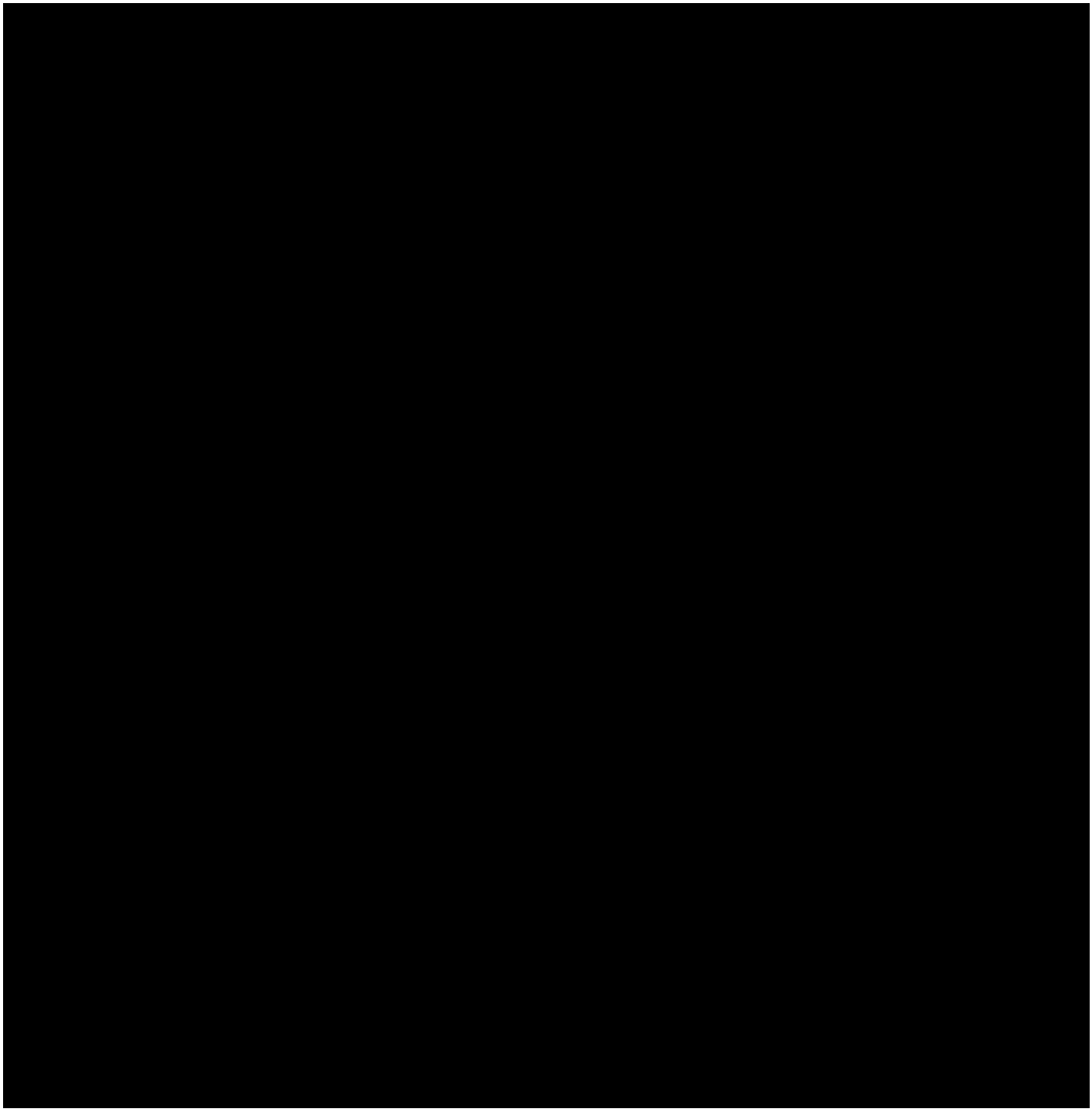


Kind regards

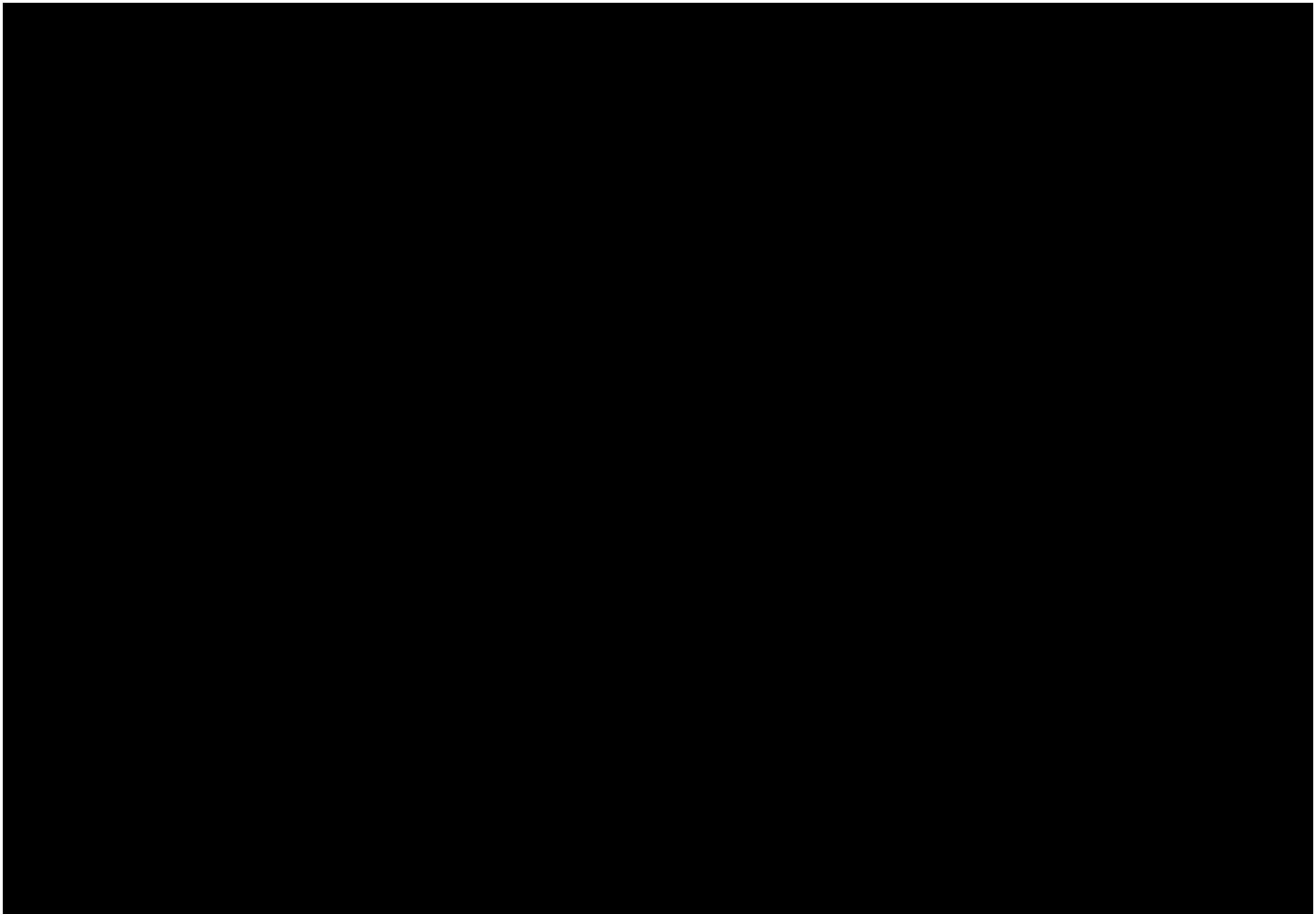
Emily Beresford-Cane
Tamboran Resources

www.tamboran.com
Tamboran Resources Limited ABN 28 135 299 062
GPO Box 4025, Darwin NT 0801 Australia

[redacted]

Tamboran Resources Limited
ABN 28 135 299 062
110-112 The Corso, Manly NSW 2095

Telephone +61 (2) 8330-6626



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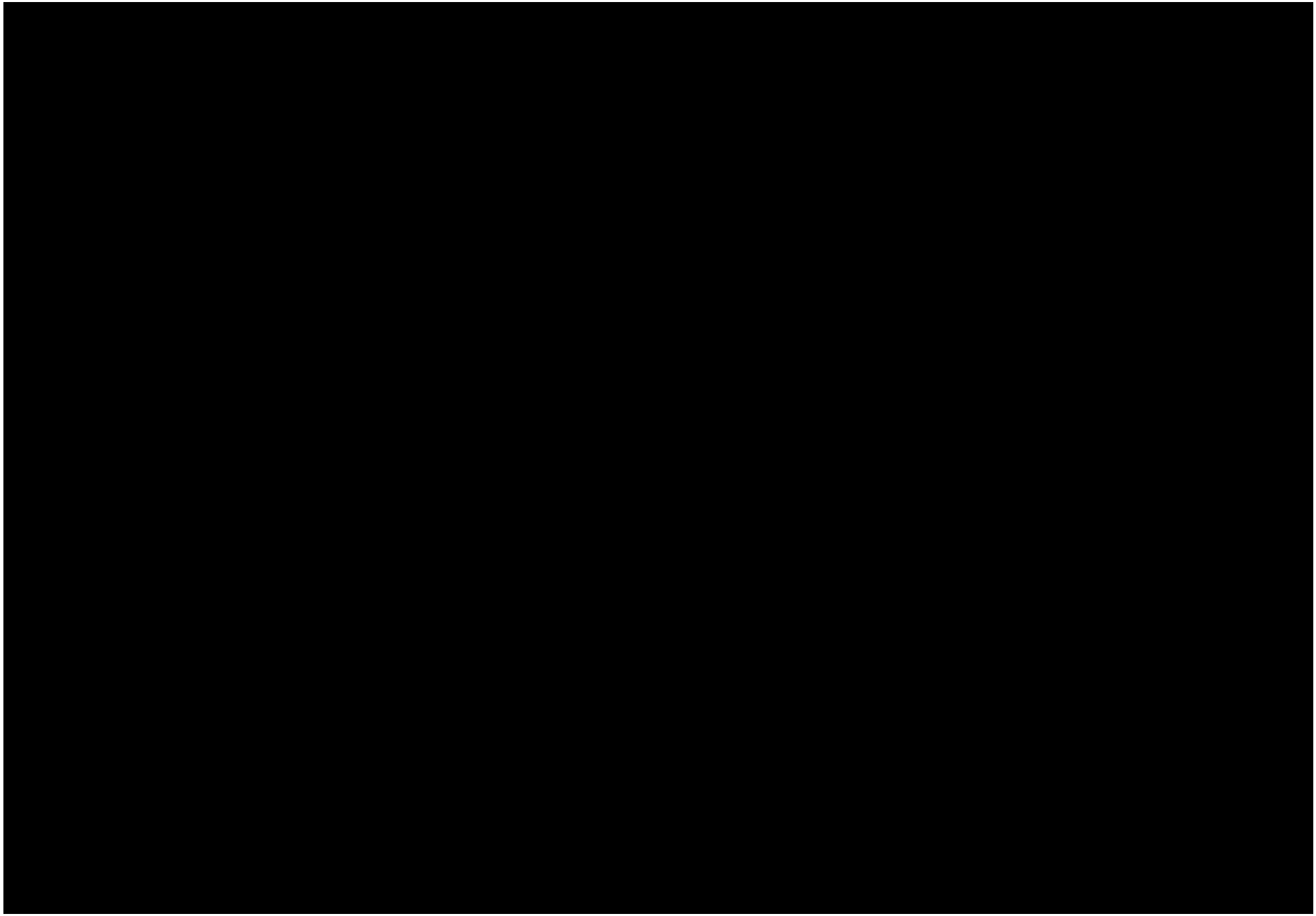

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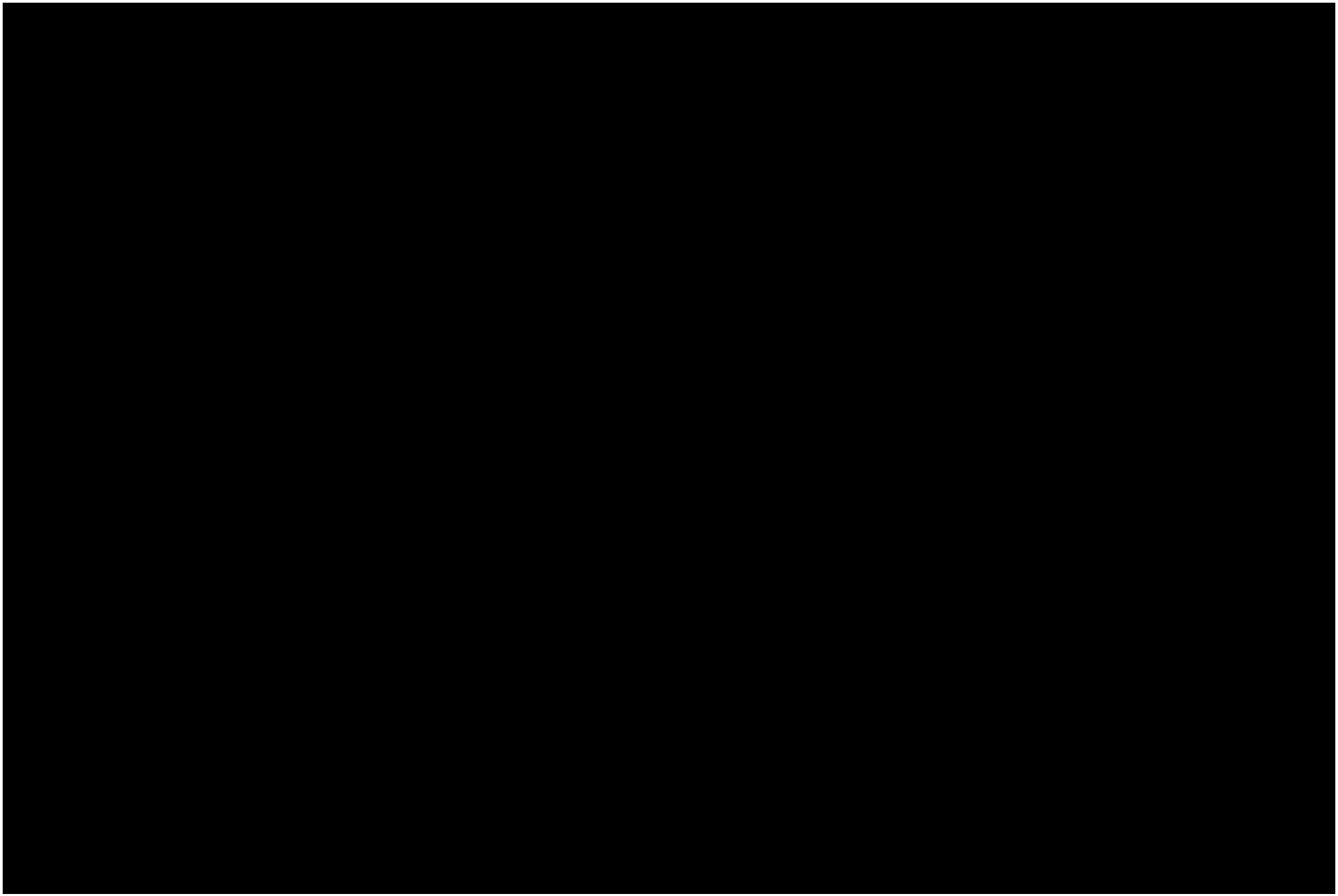

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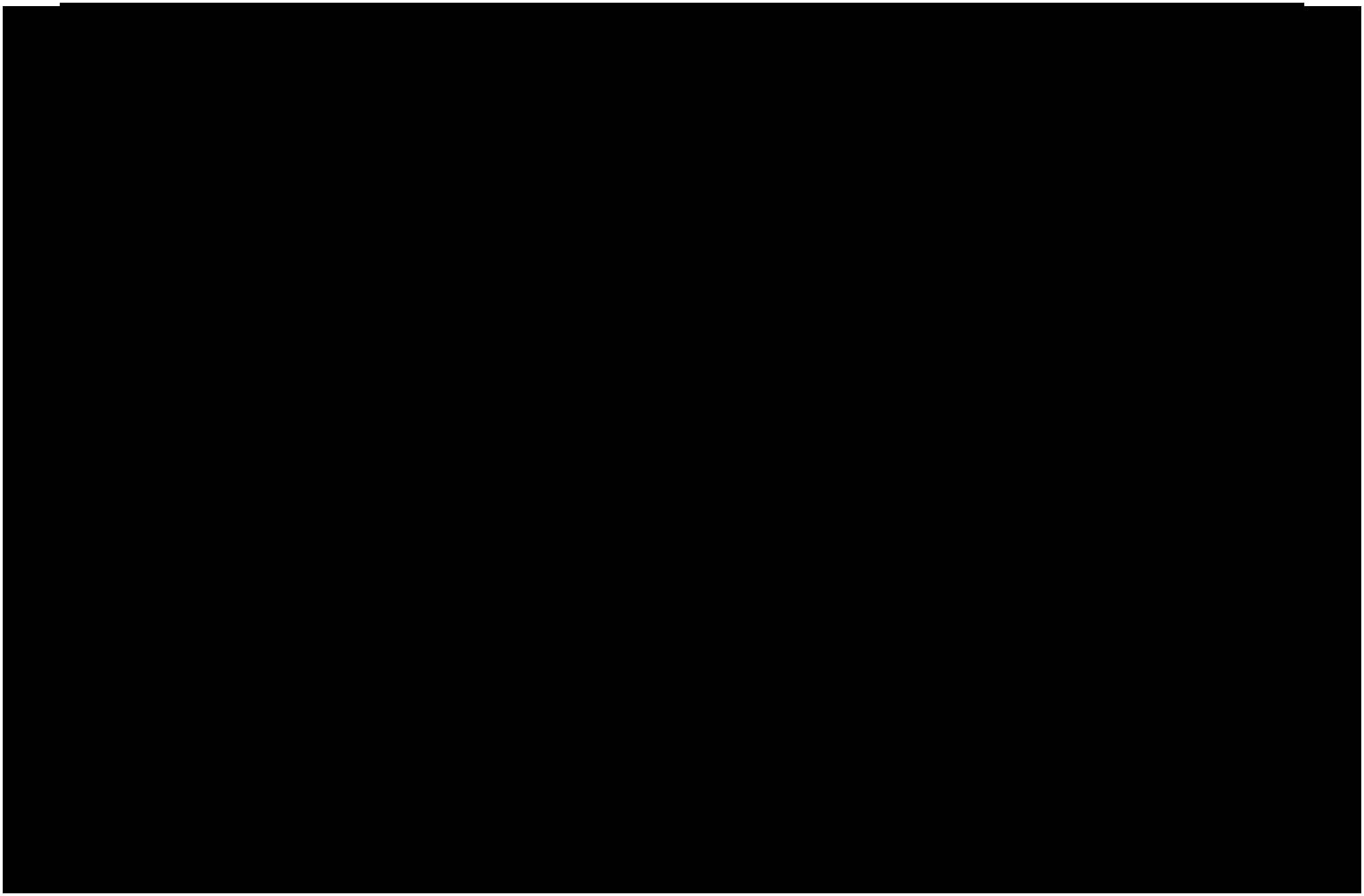

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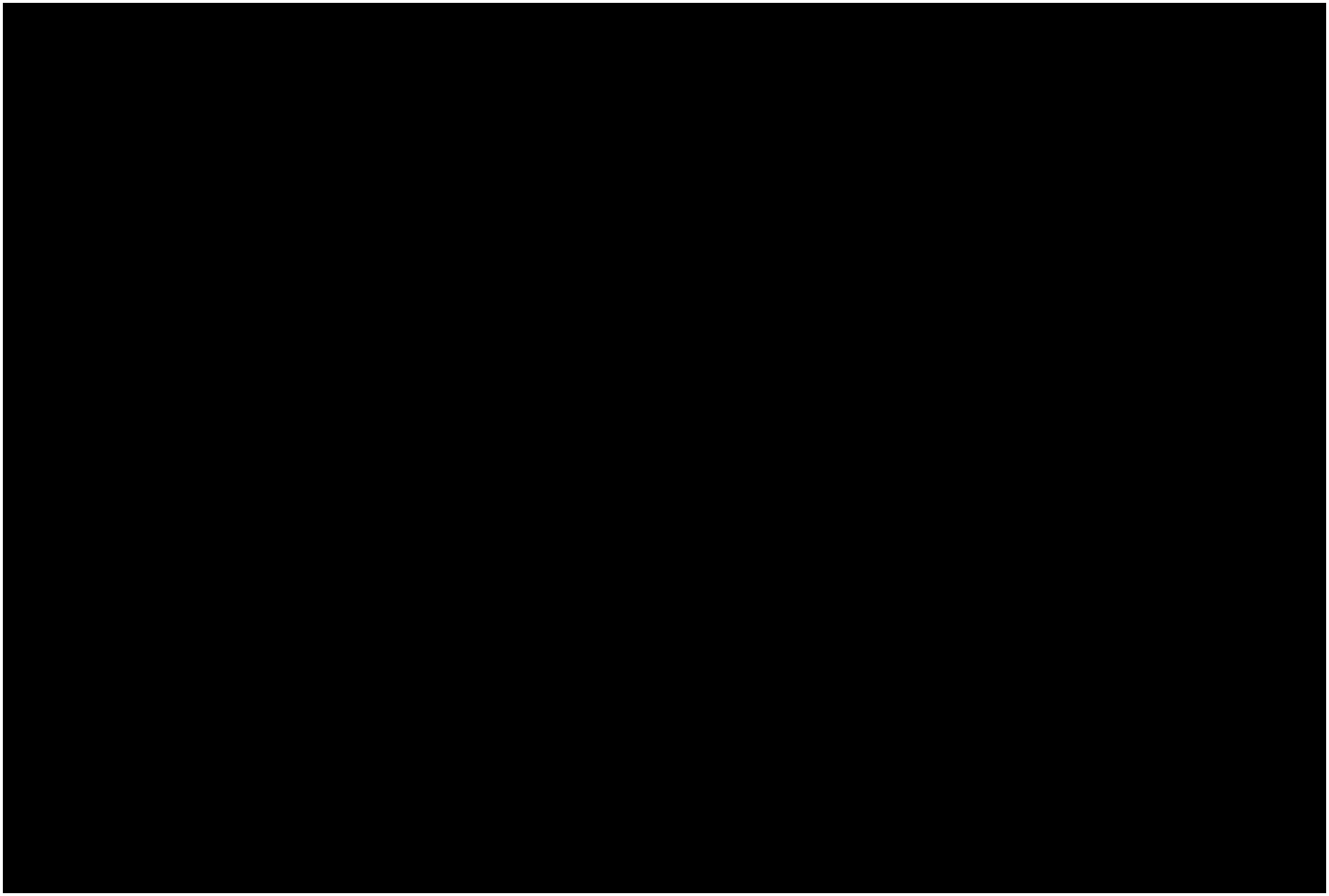

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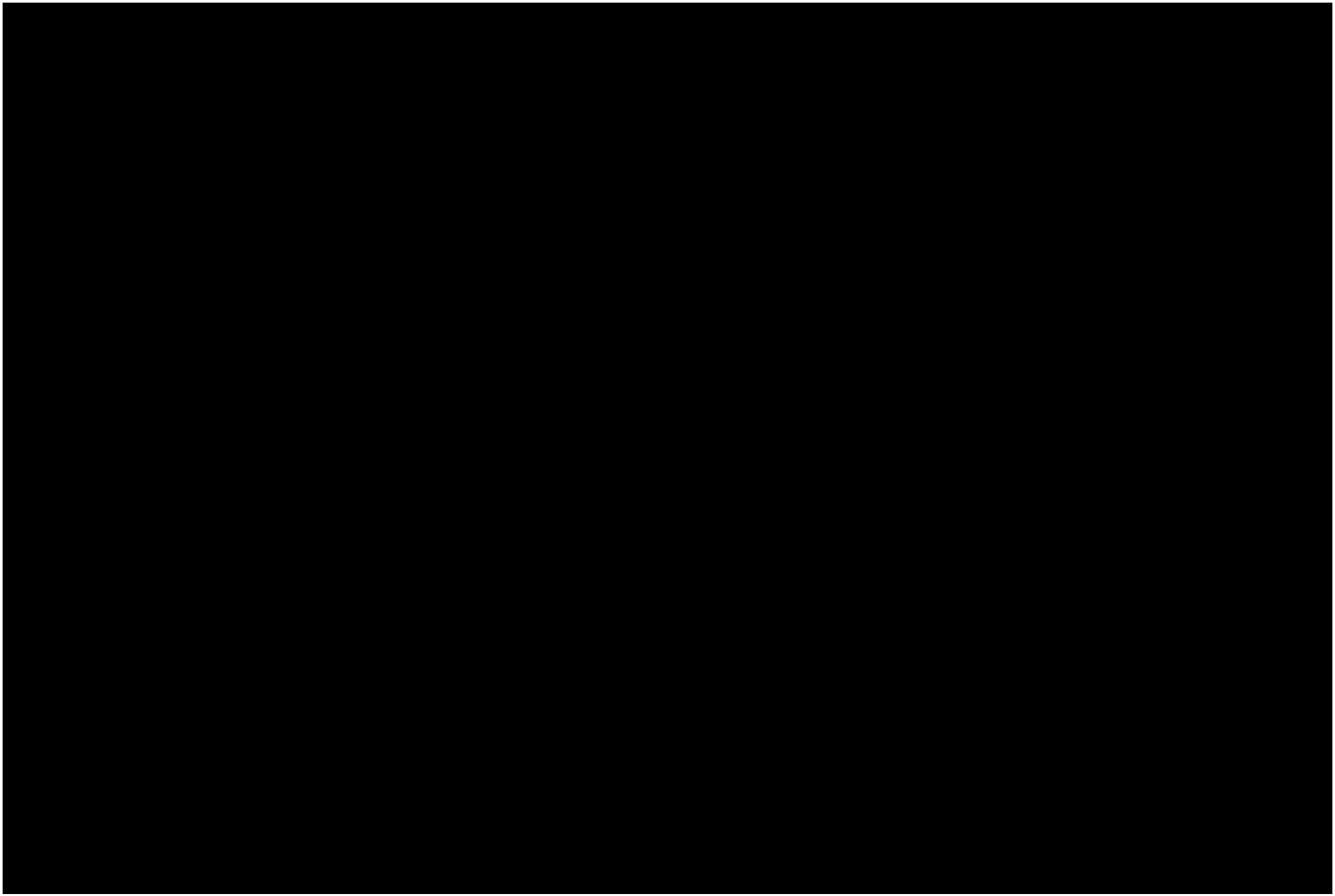

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Appendix N.1.2 24 230927 Email & presentation

From: Emily Beresford-Cane
Sent: Wednesday, 27 September 2023 11:52 AM
To: [redacted]
Cc:
Subject: Draft Presentation - Tamboran/NTH/NLC Meeting 29th September
Attachments: DRAFT NLC Tamboran Mtg 29 Sept 2023.pdf

Hi Jeremy

Please find attached Draft Presentation for the meeting with NTHs and NLC on Friday 29th. Please note that there may be some final tweaks before the meeting.

If the NLC have feedback on the presentation - please feel free to email me comments or alternatively, we can schedule a call to discuss if that is easier.

Kind regards

Emily

NLC-Tamboran Project Update and Work Program Meeting

29 September 2023

Agenda

1. Introductions
2. About Tamboran
3. Proposed Production Agreement Area
4. Roadmap to Production
5. Beetaloo Exploration
6. Beetaloo Project
7. Key ASX announcements
8. Work Program and Approvals for 2023 and 2024
9. ILUA and Joint Negotiation Working Group
10. Community Projects
11. Next steps
12. Questions

About Tamboran

Introducing Tamboran

We are a publicly listed Australian company with our headquarters in Sydney and staff across Australia and the USA. We are committed to creating value for our shareholders, communities, Territorians and Australians by appraising and developing the gas resources of the Beetaloo Basin. We strive to follow and exceed the example set by Origin in community engagement since 2014 and will continue to focus on economic, development and employment opportunities for Native Title Holders and local communities.

Our Vision

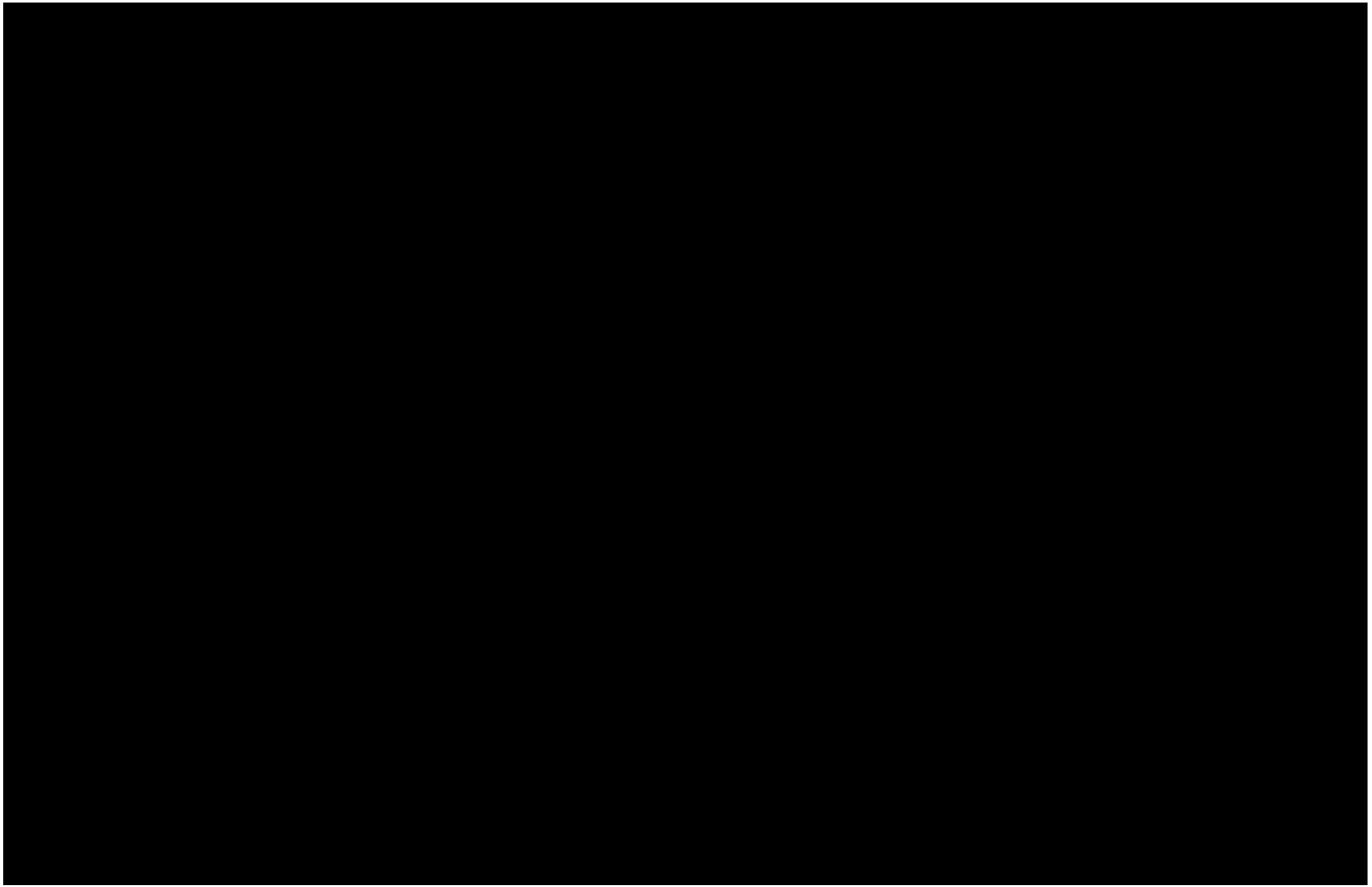
To play a role in the global energy transition by investing in the development of low CO2 unconventional natural gas resources in the Beetaloo Sub-basin of the Northern Territory of Australia and to become a Net Zero carbon emissions gas producer for our equity share of Scope 1 and Scope 2 emissions when the Company achieves commercial gas sales.

Strategy

- Target is to become a Net Zero equity Scope 1 & 2 emissions producer
- Focused, high growth Beetaloo strategy
- High quality assets with significant scale
- Low-cost development targeting multiple markets, premium pricing
- Expertise in unconventional E&P development

Sustainability

- Health & Safety
- Climate Change
- Environment
- People
- Community
- Economic Sustainability



Beetaloo Exploration and Production

Beetaloo Exploration Project

tamboran RESOURCES

Tamboran Resources, together with joint venture partners Daly Waters Energy and Falcon Oil and Gas, is exploring for gas in the Northern Territory's Beetaloo Basin.

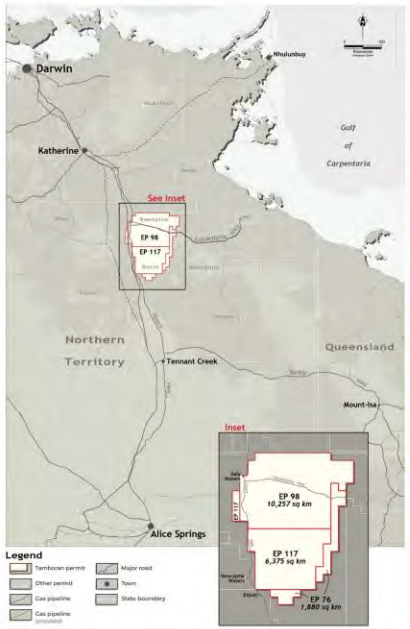
The Resource Potential

Our exploration project in the Beetaloo Basin is a multiyear, shale gas project that started in mid-2014. So far, the Beetaloo Joint Venture (previously led by Origin) has drilled seven wells. All within regulations and with the consent of the pastoralists and Native Title holders.

We plan to drill bring a new drilling rig in to Australia this year (2023), which will be used to drill between 2-6 wells for the next 2-3 years.

We think there's a very large gas resource underneath the ground with outstanding potential. Today our project has as much as 61 trillion cubic feet of gas, with 6.6 trillion cubic feet of that already recognised as a contingent resource*. Just how big is this? The Inpex project is 12 trillion cubic feet and the Mereenie gas fields have produced around 240 billion cubic feet since the mid 1980's.

* Amungee well estimate



The Benefits

If successful, and development goes ahead, the project means:

- more work for and jobs with local companies, including Aboriginal companies
- the opportunity to supply goods and services to the project
- financial payment for host pastoralists and Native Title holders
- taxes and royalties – providing government with more money that can go to improving community services, infrastructure and telecommunications
- energy security (delivering gas to the Eastern Australia)

Beetaloo Project

tamboran RESOURCES

Moving from Exploration through to Development

Exploration, appraisal and piloting
Several individual sites spread over a large area

Development and production
Concentration of sites and supporting infrastructure over a smaller area

Typical Processing Hub

Typical Multi-well Layout

Typical Solar Farm

Water Storage

Typical Campsite

Exploration

- Is there gas?
- 1-2 wells per year
- typically smaller sites with vertical wells with no fracking or gas produced
- 2D seismic used to assess whether rocks are continuous

Appraisal and Piloting

- What type of gas and how much?
- Increasing number of wells- typically 2-6 per year.
- Larger sites to store more equipment with multiple wells per site
- Horizontal wells drilled which are fracked and tested to see how much gas can be produced

Development and production

- Extract gas from target formations to supply for both domestic and international customers
- Construction and operation of infrastructure required to support production, including gathering pipelines , multiple gas processing facilities, warehouses, laydowns, camps, wastewater treatment areas, renewable and gas fired energy generators
- increasing number of wells drilled and stimulated per year to maintain production ranging from ~ 6 to 60 depending on size of project and demand
- Small lease pads with centralized infrastructure
- All gas sold, with minimal Greenhouse gas emissions during production
- Progressive rehabilitation of wells and wellsite's once production has finished
- Typically 30+ years

Beetaloo Project

tamboran RESOURCES

Rehabilitation

Rehabilitation
Progressive fixing of country back to pre-existing state

Development and production

Rehabilitation

- Country progressively rehabilitated as activities finish
- Production wells plugged with cement and rehabilitated
- Infrastructure remove, with topsoil and vegetation reinstated
- Multiple years of rehabilitation

Conventional and Unconventional

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Conventional and Unconventional are industry terms used to define where gas is found underground and how it's extracted.

It's the same gas (natural gas reserves are mostly methane with some propane, butane and light condensates) - the main difference is how it occurs in nature today.

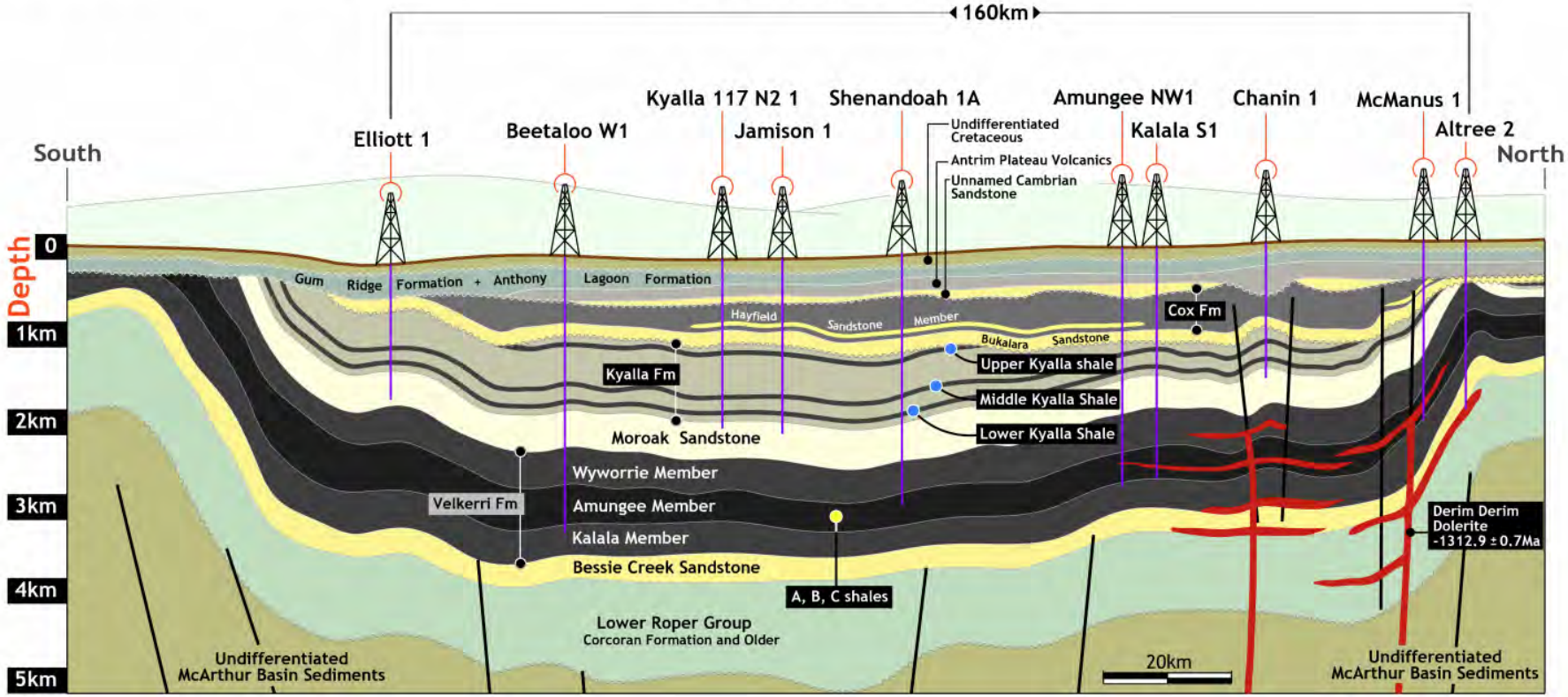
Conventional gas has typically migrated from where it formed millions of years ago to a sandstone reservoir where it's trapped between porous grains under a denser layer of rock that acts as a cap or seal.

Unconventional gas is typically extracted from where it formed, in coal seams or shale formations that can be less porous and are sometimes described as tighter.

Extracting gas from either source can require a range of different techniques and processes

It's a common misunderstanding that conventional reserves do not require fracture stimulation and unconventional reserves do.

For example, around a third of conventional wells in the Mereenie field near Alice Springs have been fracced.



Drilling For Shale Gas

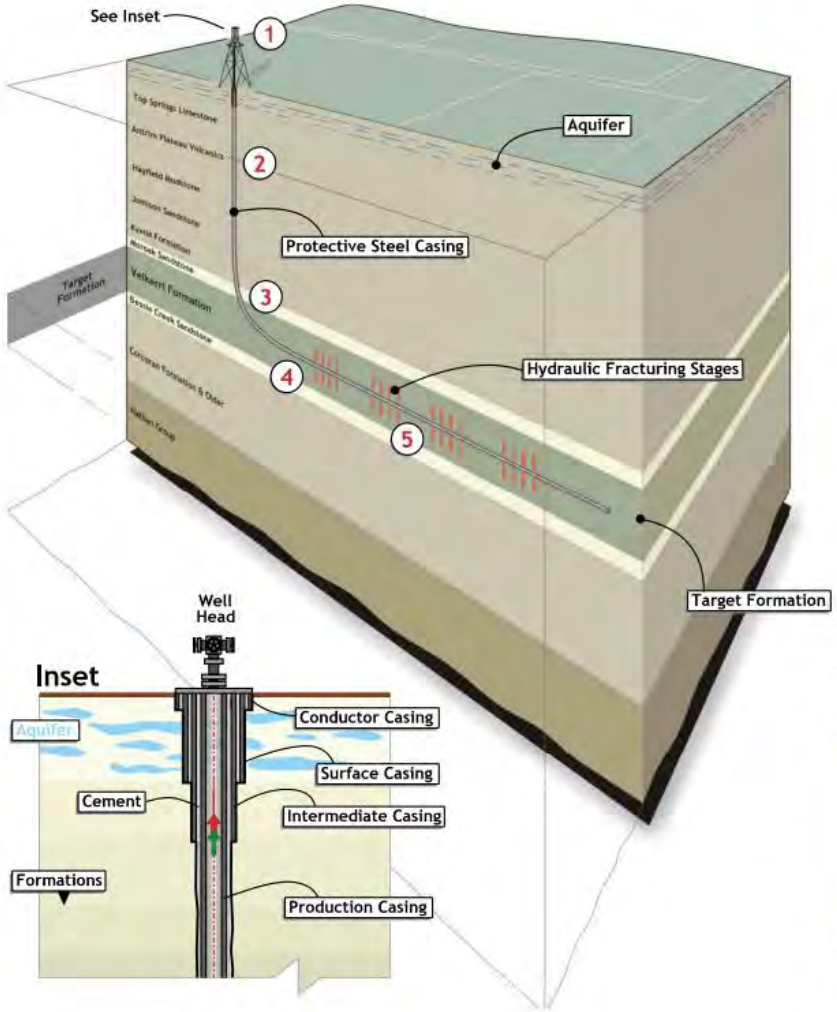
tamboran
RESOURCES

Our exploration program includes drilling both vertical and horizontal wells that target the underground shale rock formations in the Beetaloo Basin.

Long Reach Horizontal Drilling

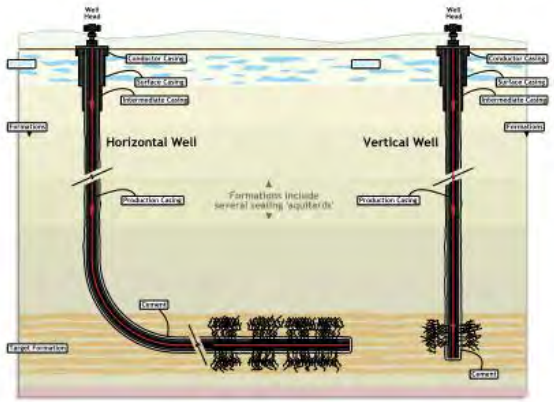
Steps in Horizontal Drilling:

1. Negotiate and agree access, obtain approval and bring in drilling rig and equipment
2. Drill vertical section of well using conventional methods
3. Drill kick-off (curved) section, with the use of a downhole motor mounted directly above the bit, in order to make the turn from vertical to horizontal. Downhole instruments called MWD (measuring while drilling) packages transmit sensor readings upward, allowing operators at the surface to build the angle
4. Drill horizontal wellbore, still using MWD to hold the angle and direction
5. Case off the well with steel casing and cement to allow for completion and fracture stimulation, preparing the well for production



Vertical Wells and Long Reach Horizontal Wells

- Tamboran will drill both vertical and horizontal wells during the Exploration Phase/s
- Vertical wells allow a more cost effective assessment of the potential for gas and liquids in the target zones and provide some information on production capability
- Horizontal wells will be required to assess the potential for economic gas and liquid recovery rates
- Horizontal wells are most likely to be required for field development



Hydraulic Fracture Stimulation (Fracking)

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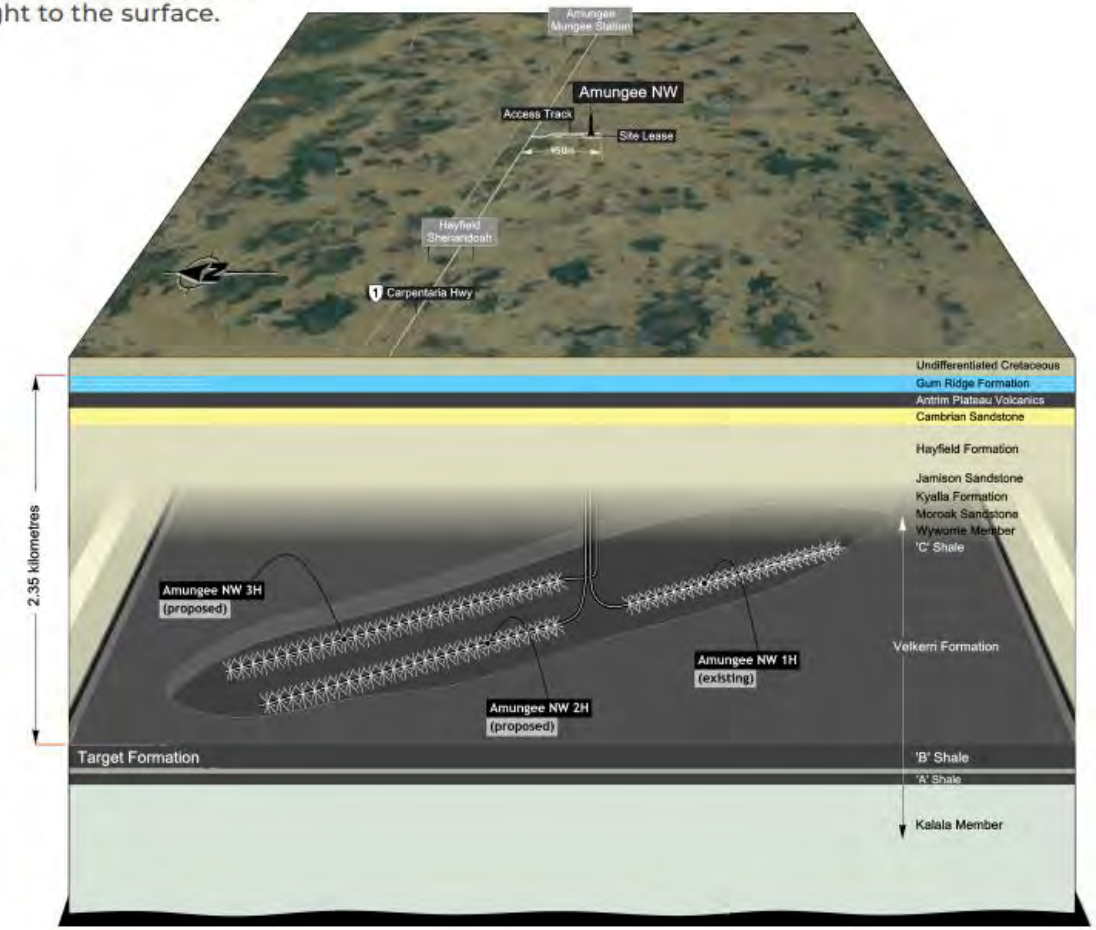
Fracking is the technical process designed to release the gas trapped in the dense shale rocks deep underground.

It involves pumping water mixed with sand and some chemical additives in low concentrations under pressure to fracture the shale, creating tiny pathways in the rock that allow the gas to flow into the well and be brought to the surface.

Key facts about fracking in the Beetaloo

- Distance offers initial protection – 1-2km between the shallower aquifers and the deeper rocks where gas is found.
- Both zones are effectively sealed off by several thick geological layers in between called aquatards.
- It's not physically possible for a fracture to extend upwards into the aquifer. Because of the distance, and because the amount of energy and pressure used in fracking isn't enough to connect and create pathways outside of the rock formation where gas is found.
- Any natural vertical fractures or discontinued bores are extremely unlikely to provide a pathway for fracking fluids to reach a fresh water zone due to the greater weight (what's called hydrostatic head pressure) pushing down from above.
- Seismic work allows us to map the geology and avoid any large structures or faults.



Hydraulic Fracture Stimulation (Fracking) Part 1

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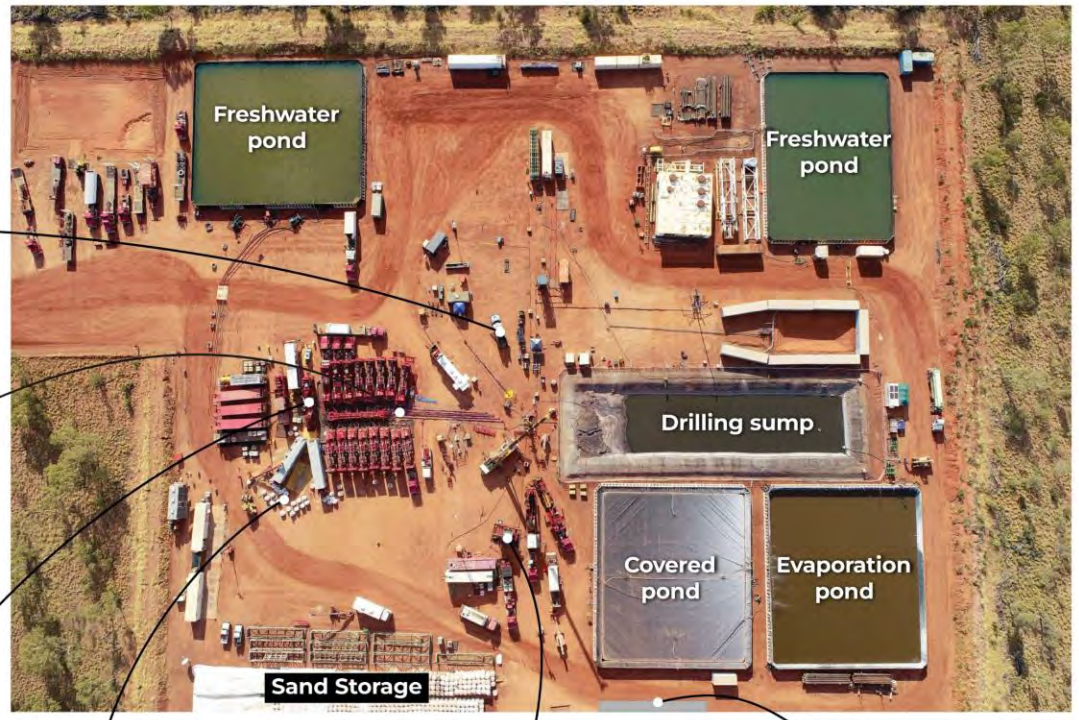
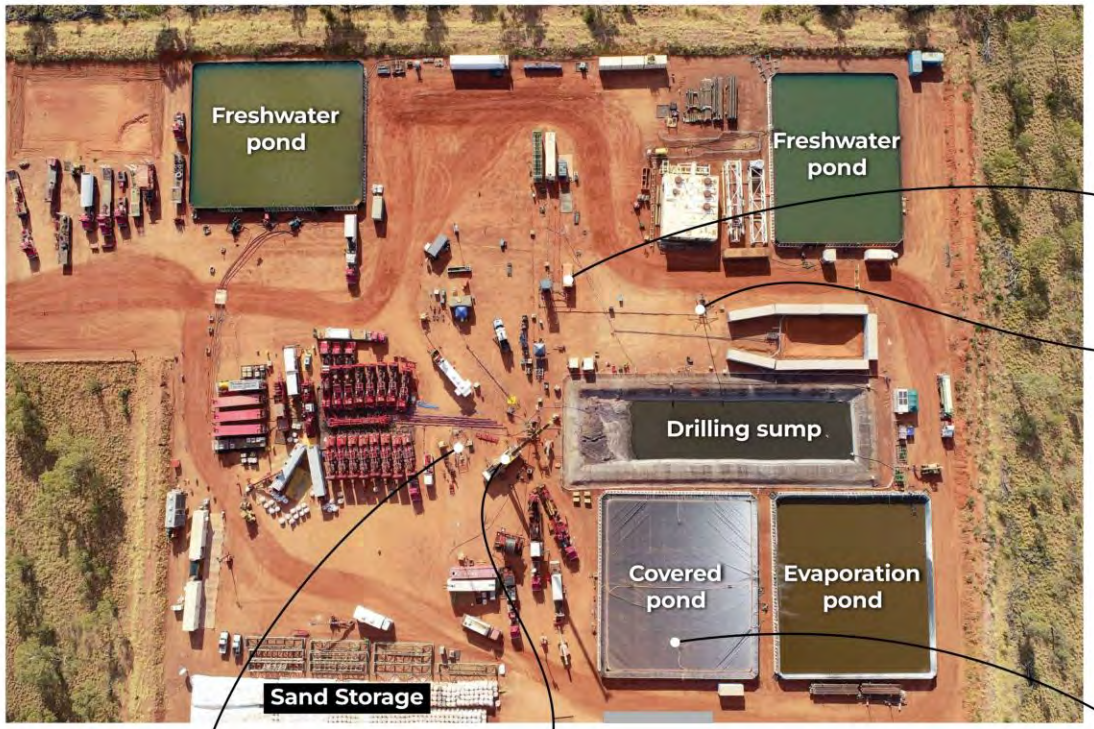


Hydraulic Fracture Stimulation (Fracking) Part 2

tamboran RESOURCES



Gas and condensate separators

Flare

Groundwater monitoring bores

Well head and crane

Covered ponds

Production Testing

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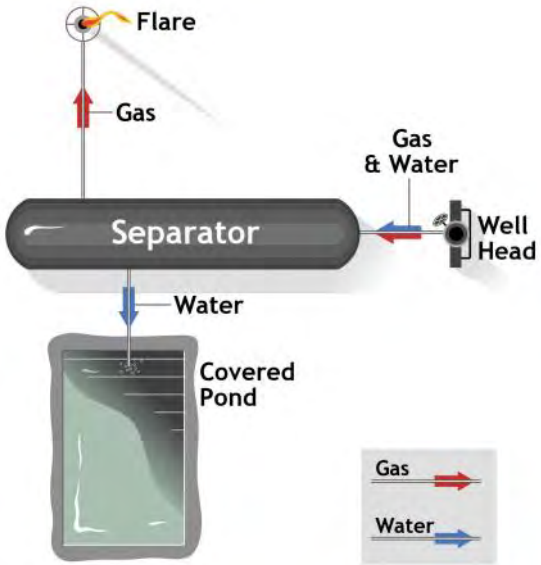
Production testing occurs after a well is successfully drilled and fracture stimulated, and sufficient volumes of fluids pumped down during these stages is returned to surface to allow the well to flow on its own.

The purpose of production testing is to understand the deliverability of the well.

Gas flow from the well is directed to a separator. From there any water is sent to on site ponds. The gas produced is sent to a flare where it is combusted. During exploration, flaring is a better environmental outcome than venting.

Data is gathered about the composition, the rate and how much gas the well is able to flow over a period of time. This information allows estimations to be made about how much of the resource is recoverable.

Production testing, often called extended production testing, can occur over a number of months. The longer the test the greater the confidence that can be gained about the extent of the resource.



Vertical flare

Covered flow back pond

Separator

Horizontal flare

Well Integrity and protecting groundwater

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Engineering standards, steel and cement ensure the drilling and fracking of gas wells do not create a pathway between the underground layers of rock or deteriorate over time.

Built Strong - To Last The Test Of Time

A gas well has three main parts – the steel casing, the above ground well head, and cement which is engineered to be as strong as the rock that it will live in.

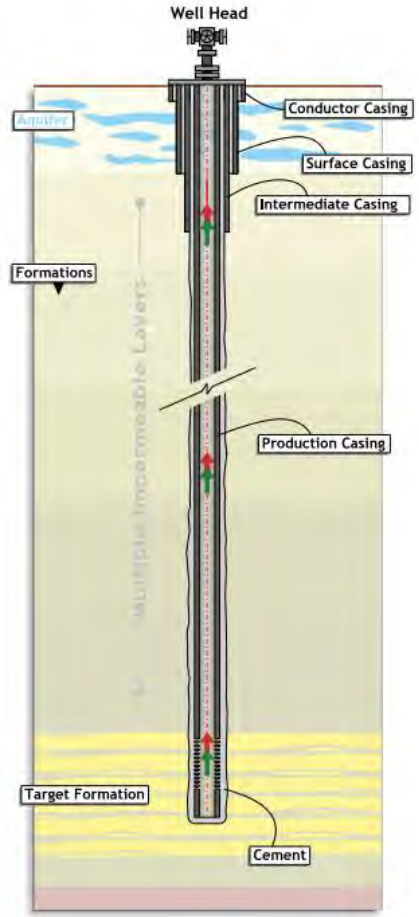
Casing and cement hold the hole open and protect or prevent any cross flow between the surrounding underground formations. The cement is pumped down the inside and back up the outside of the casing.

An x-ray device sent down the well (a technique called logging) combined with pressure testing confirm the quality of the job.

The casing is designed to ensure its strong enough to withstand the most extreme loads it could be subjected to.

Added to this is a program of regulatory control and oversight, and the requirement to appropriately decommission every well at the end of its operational life.

Well Construction - Protecting Aquifers



Engineering Standards And Performance Data

Category	Description	Risk
1	Shallow surface casing + top of production casing cement below over pressured hydrocarbon reservoir	High
2	Shallow surface casing + top of production casing cement below under pressured hydrocarbon reservoir	
3	Shallow surface casing + top of production casing cement above top of gas	
4	Shallow surface casing + top of production casing cement above surface casing shoe	
5	Deep surface casing + top of production casing cement below under pressured hydrocarbon reservoir	
6	Deep surface casing + top of production casing cement above top of gas	
7	Deep surface casing + top of production casing cement above surface casing shoe	
8	Deep surface casing + 1 intermediate casing + top of production casing cement below top of gas	
9	Shallow surface casing + 1 intermediate casing + top of production casing cement above casing shoe	
10	Deep surface casing + 1 intermediate casing + top of production casing cement above top of gas	
11	Deep surface casing + 1 intermediate casing + top of production casing cement above casing shoe	
12	Deep surface casing + 2 intermediate casing strings + top of production casing cement above casing shoe	Low

Tamboran's minimum design requirement for a producing well

Tamboran's minimum design requirement for a P&A well

Tamboran's Beetaloo wells

(a) Vertical and deviated wells

CATEGORY	ORIGINAL WELL COUNT	POTENTIAL BARRIER FAILURES	POTENTIAL BARRIER FAILURES %	CATASTROPHIC BARRIER FAILURES	CATASTROPHIC BARRIER FAILURES %	AVG COMPLETION DATE	P&A WELL COUNT	CURRENT WELL COUNT	ORIGINAL AVG SURFACE CASING DEPTH (FT)	ORIGINAL AVG TOP OF PRODUCTION CEMENT (FT)
Category 1	166	100	60.24%	1	1.81%	1979	57	15	253	7,334
Category 2	621	219	35.27%	5	0.81%	1983	138	301	306	6,566
Category 3	46	16	34.78%	1	2.17%	1982	14	31	321	4,008
Category 4	7	0	0.00%	0	0.00%	1982	1	15	222	125
Category 5	8,789	77	0.88%	1	0.01%	1995	782	6,140	559	8,111
Category 6	5,433	6	0.11%	0	0.00%	2007	105	7,183	712	2,816
Category 7	1,766	0	0.00%	0	0.00%	2009	8	2,040	719	534
TOTAL	16,828	418	2.48%	10	0.06%		1,105	15,723		
D&A	147									

(b) Horizontal wells

CATEGORY	ORIGINAL WELL COUNT	POTENTIAL BARRIER FAILURES	POTENTIAL BARRIER FAILURES %	CATASTROPHIC BARRIER FAILURES	CATASTROPHIC BARRIER FAILURES %	AVG COMPLETION DATE	P&A WELL COUNT	CURRENT WELL COUNT	ORIGINAL AVG SURFACE CASING DEPTH (FT)	ORIGINAL AVG TOP OF PRODUCTION CEMENT (FT)
Category 1	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 2	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 3	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 4	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 5	0	0	0.00%	0	0.00%	NA	0	0	NA	NA
Category 6	269	0	0.00%	0	0.00%	2012	1	268	789	2,153
Category 7	704	0	0.00%	0	0.00%	2012	2	702	929	442
TOTAL	973	0	0.00%	0	0.00%		3	970		
D&A	0									

Protecting Groundwater

tamboran RESOURCES

We understand how important groundwater resources are to Traditional Owners, pastoralists and the community. Both engineered and natural geological barriers isolate and protect underground water sources.

Multiple controls are put in place to protect the environment and groundwater. If these controls aren't successfully met when we drill - we don't frack.

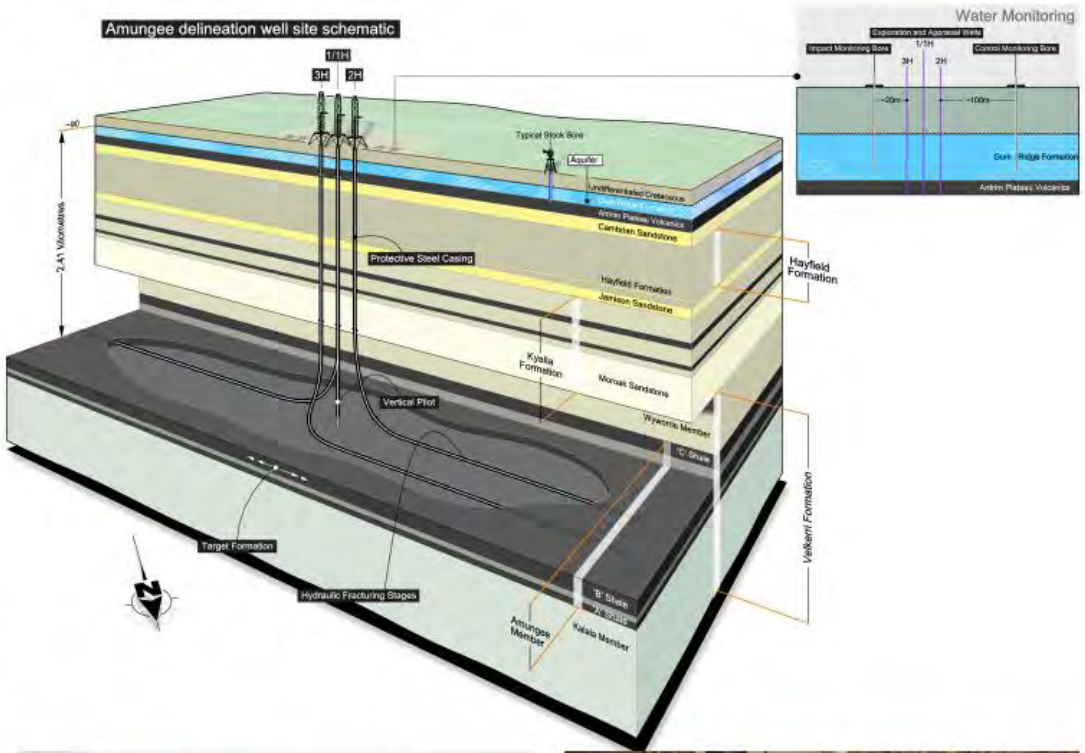
Protecting Groundwater

The Beetaloo Basin where Tamboran operates is underlain by two limestone aquifers in the area - the Anthony Lagoon Beds, which lies between 60 and 200 metres below surface, and the Gum Ridge formation, which lies between 200 and 400 metres below the surface. The horizontal section of Tamboran's existing and proposed wells are located in the Velkerri shale formation, separated by the deepest aquifer by approximately two Groundwater monitoring is a regulatory requirement that allows us to detect any potential groundwater impacts that may occur from exploration activities.

Monitoring bores are completed in the Anthony Lagoons Formation(where present) and Gum Ridge Formation on well pads where wells have been hydraulically fractured. The monitoring of groundwater level and quality is required to be completed before, during and after a well is fracture stimulated to ensure any impacts are promptly identified. As well integrity is a major design feature of our wells- groundwater contamination is not anticipated to occur.

It also improves our understanding of the natural variability of water volumes and quality, and broader hydrogeological system in the Beetaloo sub-Basin.

Groundwater monitoring of the broader aquifers within the Beetaloo commenced in 2014 originally by Origin. Tamboran has continued this program and is planning on expanding it in the future. This will ensure all of Tamboran's proposed activities can occur sustainably, with no impacts on surrounding water users.



Protecting Country, Cultural Heritage and Rehabilitation

Protect Country

Protect Sacred Sites

Fixing the Country

Key ASX Announcements

Key ASX Announcements

1. EP98 well results update (Amungee NW1-2H):

- The Amungee 2H (A2H) well in EP 98 has achieved gas breakthrough, however modelling and independent third-party analysis of fluids recovered from the well have identified potential skin.
- Despite gas flow rates being potentially constrained, the well is currently flowing at a steady rate of ~0.83 million cubic feet per day (mmscfd) and averaged 0.97 mmscf over the first 50 days.
- The Beetaloo Joint Venture (BJV) does not believe this is a reservoir issue or that the initial results are indicative of the prospectivity of the Amungee area. The Amungee NW1H well achieved flow rates of >5 million cubic feet per day (mmscfd) over a normalised 1,000-metre horizontal section from the same well pad in 2021.

2. EP161 well results update (Tanumbirini 2H/3H):

- Modelling on the T3H well has demonstrated a 20-year Estimated Ultimate Recovery (EUR) of approximately 18.5 billion cubic feet (BCF) for an assumed development scale well (~3,000 metres), in-line with the most productive regions of the Marcellus Basin, USA, and one of the world's most prolific shale gas basins.

3. APA pipeline partnership:

- APA and Tamboran have signed a binding letter, which is planned to be converted into a longer-form agreement in the coming months, to jointly develop gas transmission pipelines to connect Tamboran's Beetaloo Basin assets to Australia's domestic East Coast gas market and Tamboran's proposed Northern Territory LNG development at Middle Arm.

4. LNG letters of intent:

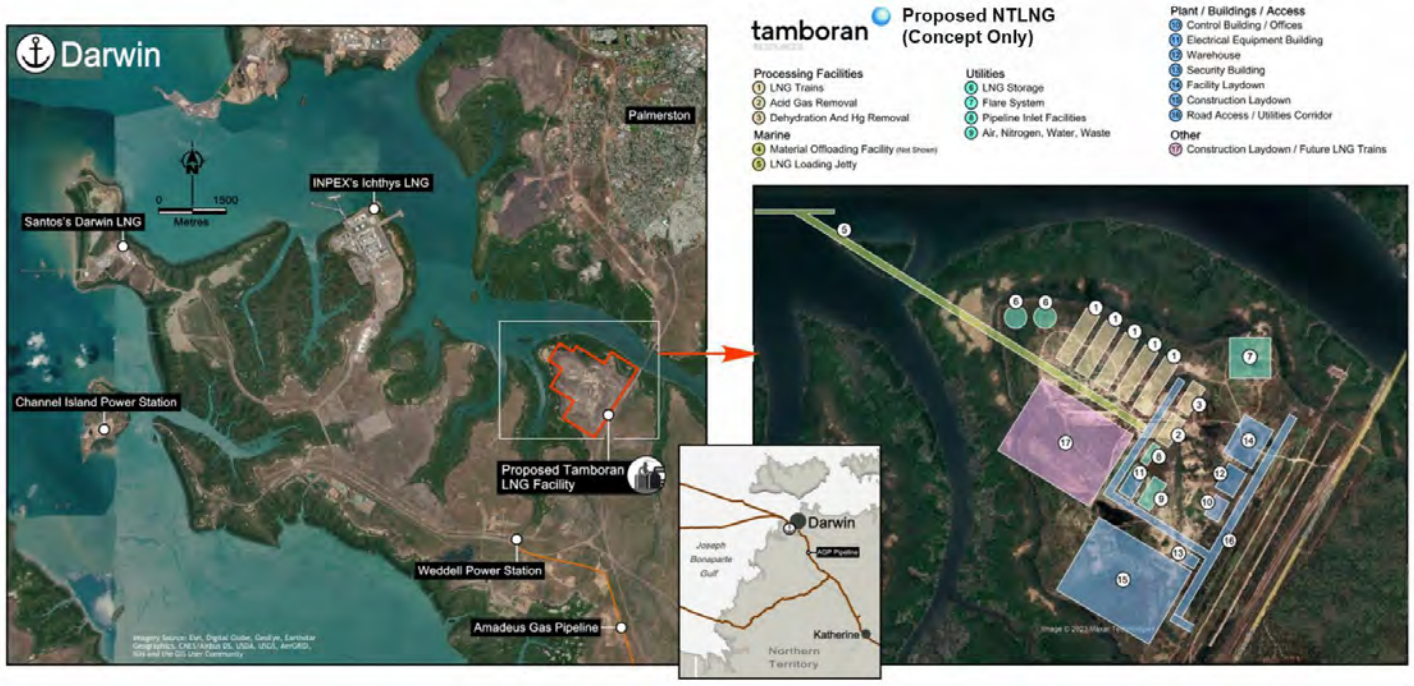
- Tamboran signs two MOUs with bp and Shell for supply of 4.4 MTPA of LNG from the Company's proposed NTLNG development

5. East Coast buyers letters of intent:

- Tamboran signs letters of intent with major east coast gas retailers illustrating demand on the timeframe of Beetaloo development

Middle Arm and NTLNG

- Middle Arm
  - The Northern Territory Government has provided Tamboran exclusivity over 170-hectares (420-acres) on the Middle Arm Sustainable Development Precinct (Middle Arm) for a proposed LNG development, Northern Territory LNG (NTLNG).
  - NTLNG is expected to be supported by low reservoir CO2 gas from the Beetaloo Basin.
  - The Middle Arm acreage has been allocated on a “Do Not Deal” basis for twelve-months, allowing Tamboran to progress a Concept Select phase for a proposed NTLNG development.

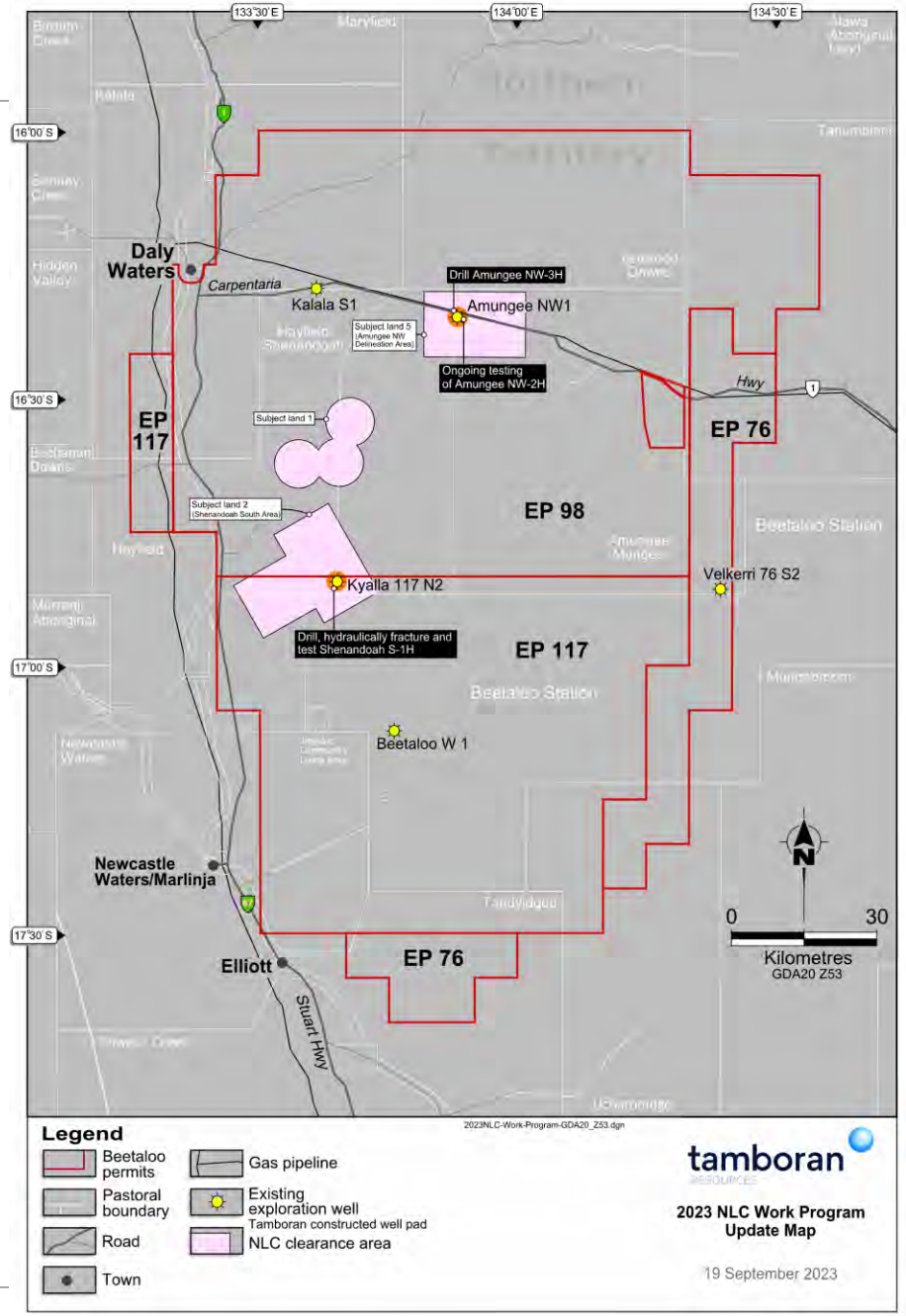


2023 / 24 Work Program

Operations update – 2023 program

- **2023 drilling program and rationale**
  - Amungee NW 2H Well testing complete
  - Shenandoah South 1-1/1H (SS1-1/1H) – well has been drilled, with hydraulic fracturing and testing proposed for November
  - Amungee NW 3H – drilling of Amungee NW 3H has commenced

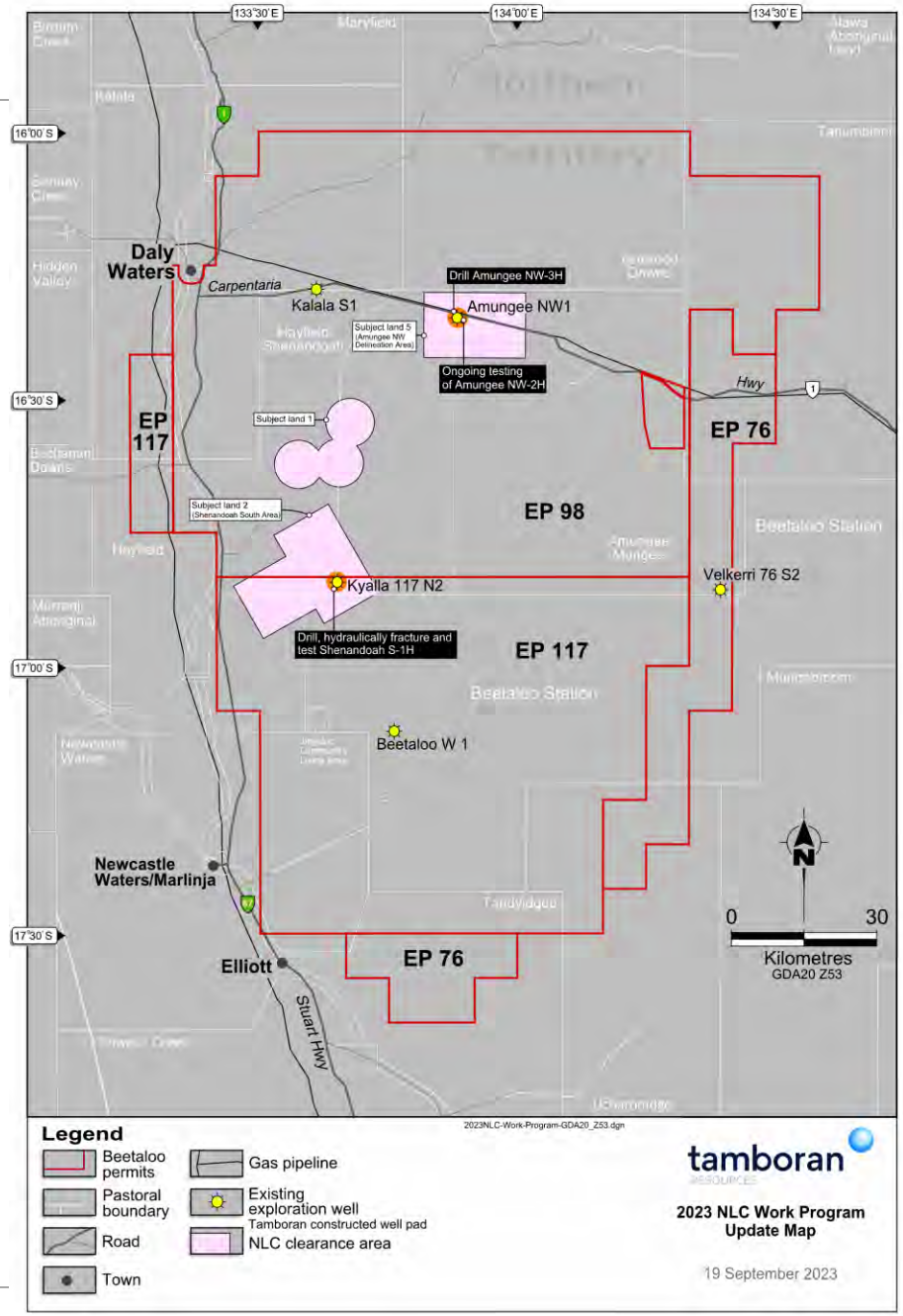
- **Cultural Managers**
  - Used for:
    - Shenandoah Sth Clearances in December 2022 and March/April 2023
    - EP136 seismic rehabilitation monitoring
  - Additional clearances around Shenandoah Sth area expected in 2024 Shenandoah Sth area expected in 2024



Indicative 2024 program

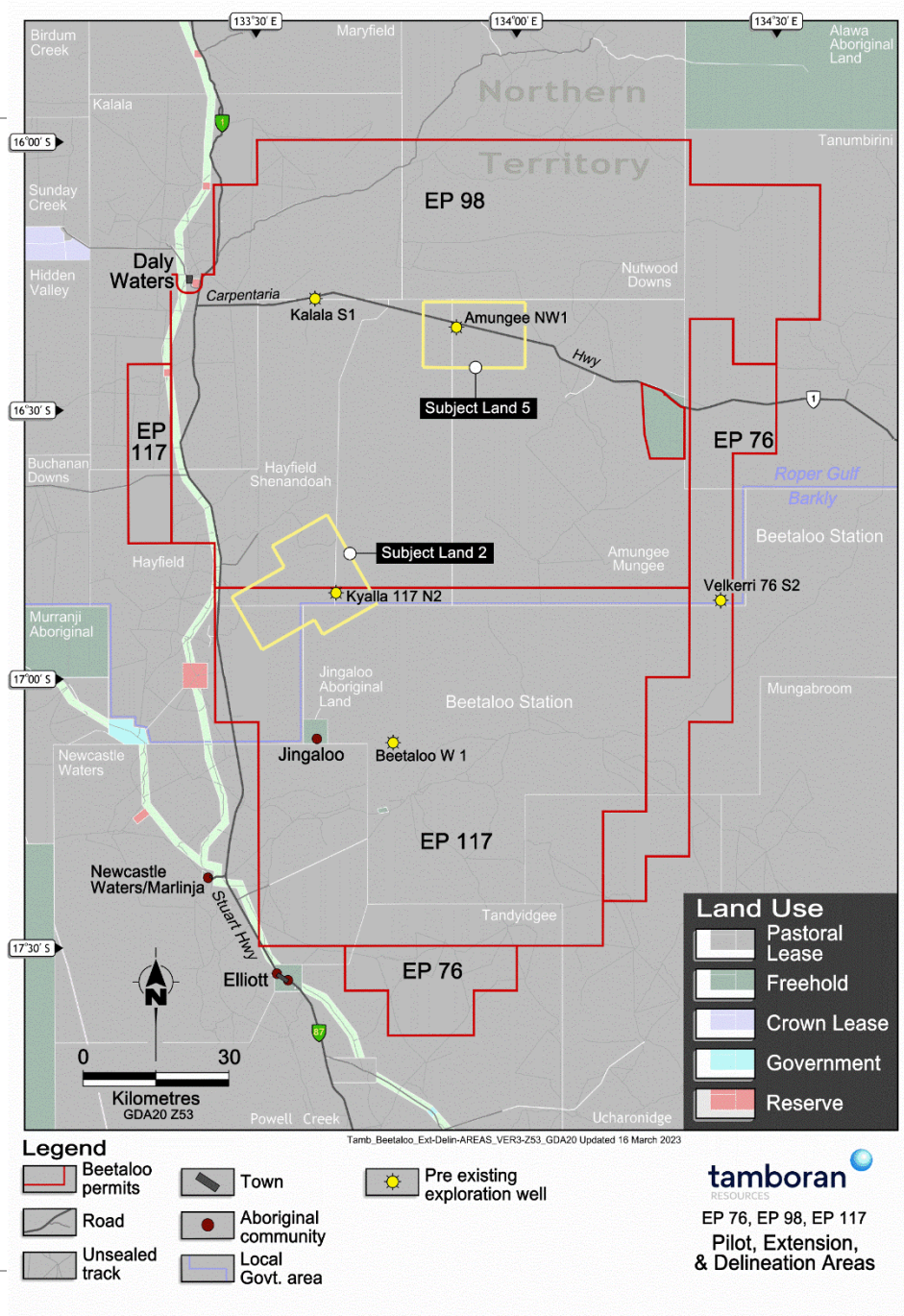
- **2024 program - pending JV agreement and approvals**
  - Amungee NW 3H hydraulic fracturing and testing
  - 2 additional horizontal wells on the existing Kyalla 117 N2 site and associated pad expansion (drill/frac/test)
  - "Step out" location – Shenandoah S2 – for 2 new wells (civils/water bores/drill/frac/test)

- **Contingent scope**
  - 2D seismic within Shenandoah Sth or Amungee NW Delineation area
  - Construction of new location Amungee NW3
  - Drilling of 2 additional wells on Amungee NW or Amungee NW3



Appraisal gas

- Success at Shenandoah Sth or Amungee Delineation will necessitate need for appraisal gas and greenhouse gas emissions
- **Appraisal gas options**
  - Locations – likely within Subject land 2 (Shenandoah Sth) and Subject land 5 (Amungee Delineation area)
  - Indicative timing – mid-late 2024
  - Indicative volumes ~10-40TJ/day depending on well productivity
  - Distribution options
  - Schedule imperatives – we seek early indication from NTHs
- **Appraisal Gas Term Sheet**
  - NTG guidelines released
  - Discussion between lawyers -Tamboran to send letter to Minister on mechanism for consent under the guidelines
  - Next steps:
    - Update and circulate Term Sheet
    - Commence discussion re NTH benefits under Term Sheet



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Sacred Site Clearances and AAPA Applications

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    - [redacted]
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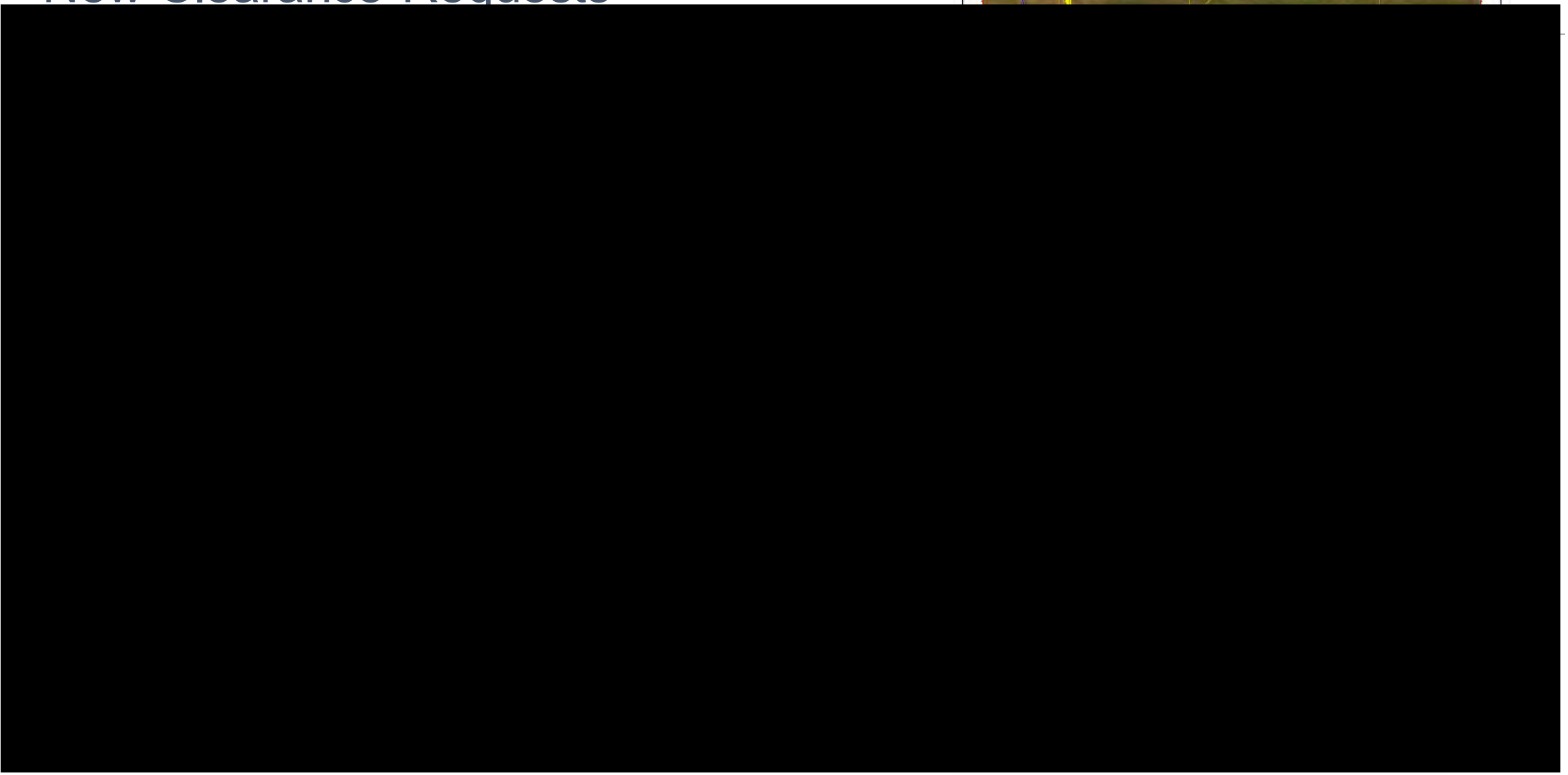
New Clearance Requests



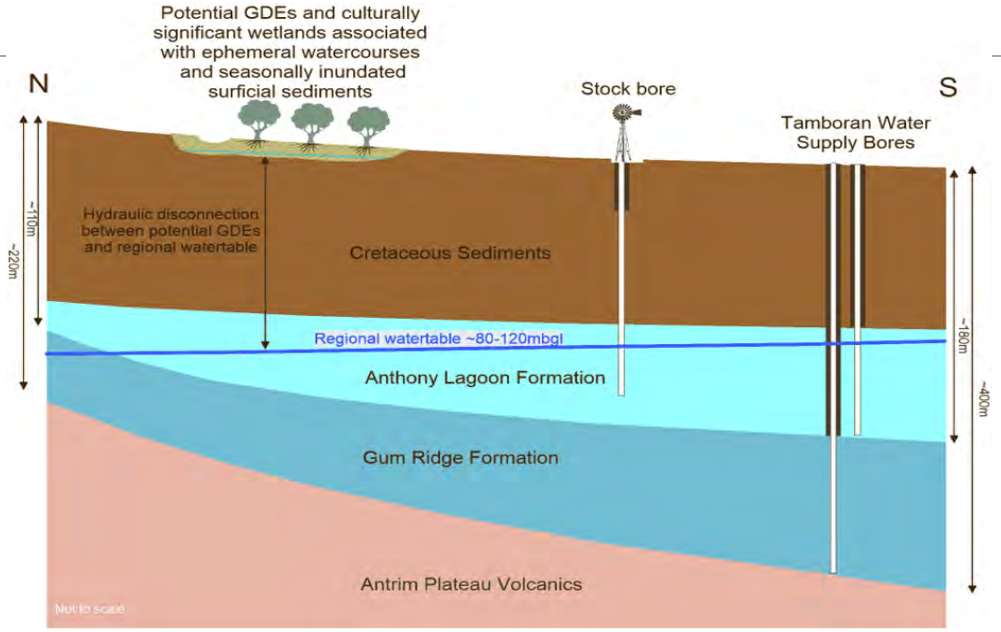
Approvals

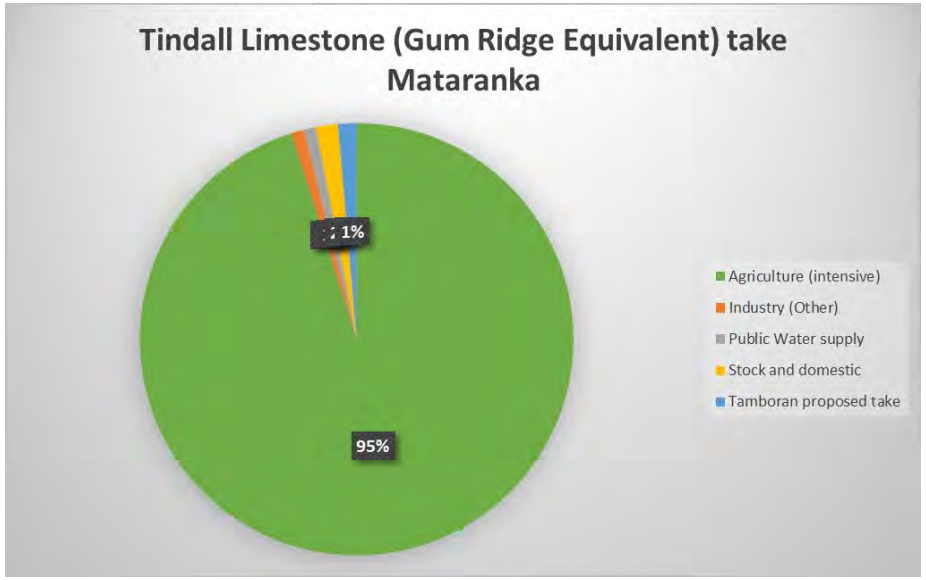
Forward approval strategy

- Tamboran will continue to progress, as required:
  - Scouting
  - Environmental approvals through environment management plans
  - Consultation with Native Title Holders
  - AAPA Authorty Certificates

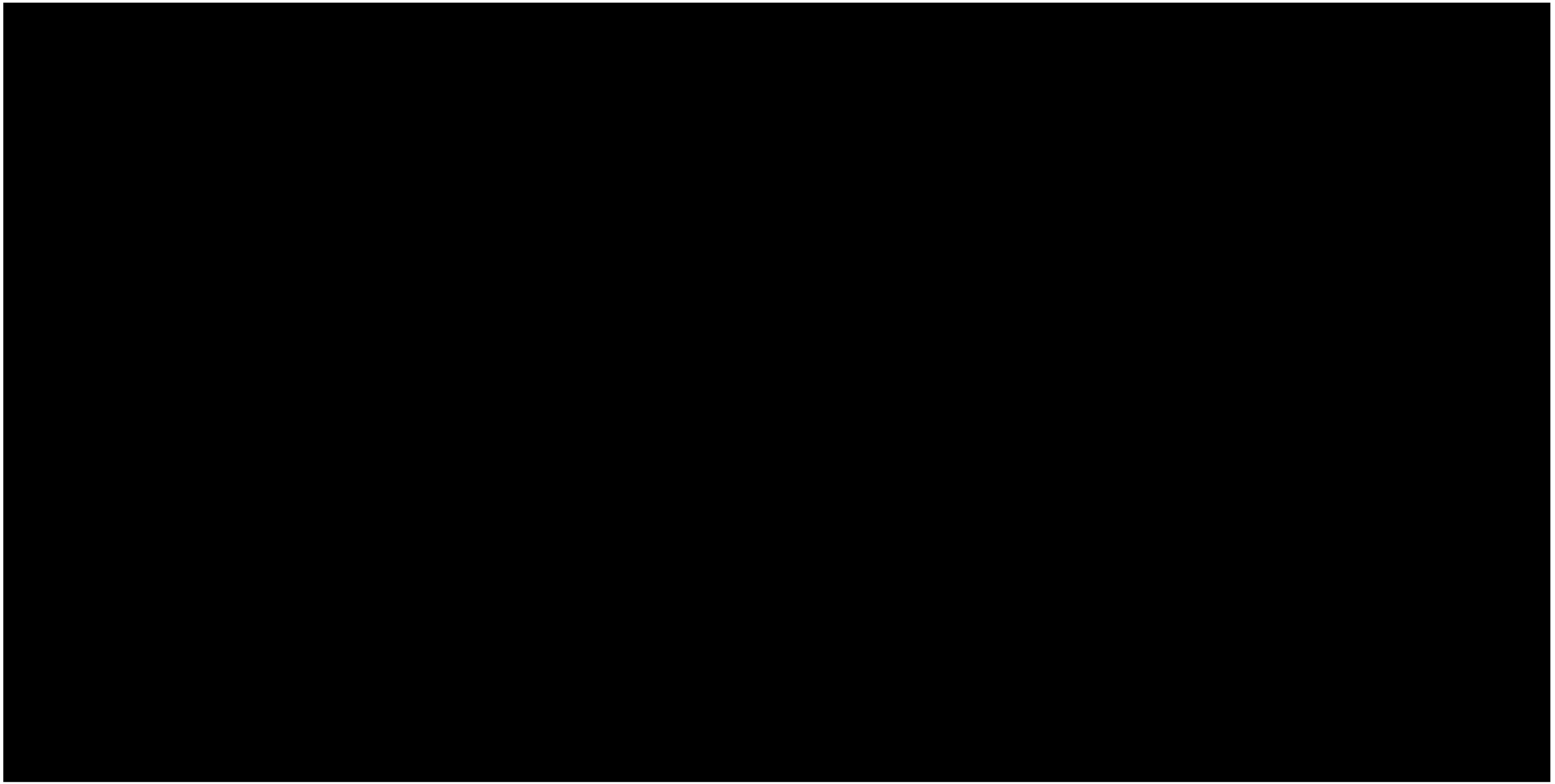
Water Extraction Licence

- Application to increase current license from 175ML/year to 450ML/year
- Increase take is required to support longer wells with more stimulations.
- Longer wells will ultimately increase water efficiency and reduce the number of wells- less surface impact and less water per unit of output.
- Proposed water take is less than 1% of current regional take
- Sacred sites associated with the Newcastle Creek, Lake Woods and other surface water bodies are not attached to the Gum ridge aquifer in the Beetaloo
- A copy of the WEL application and summary presentation was provided to NLC for comment.





ILUA and Community Project Updates



Beetaloo Project

ILUA and Areas for Agreement

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Protect Country

Protect Sacred Sites

Training and Jobs

Fixing the Country

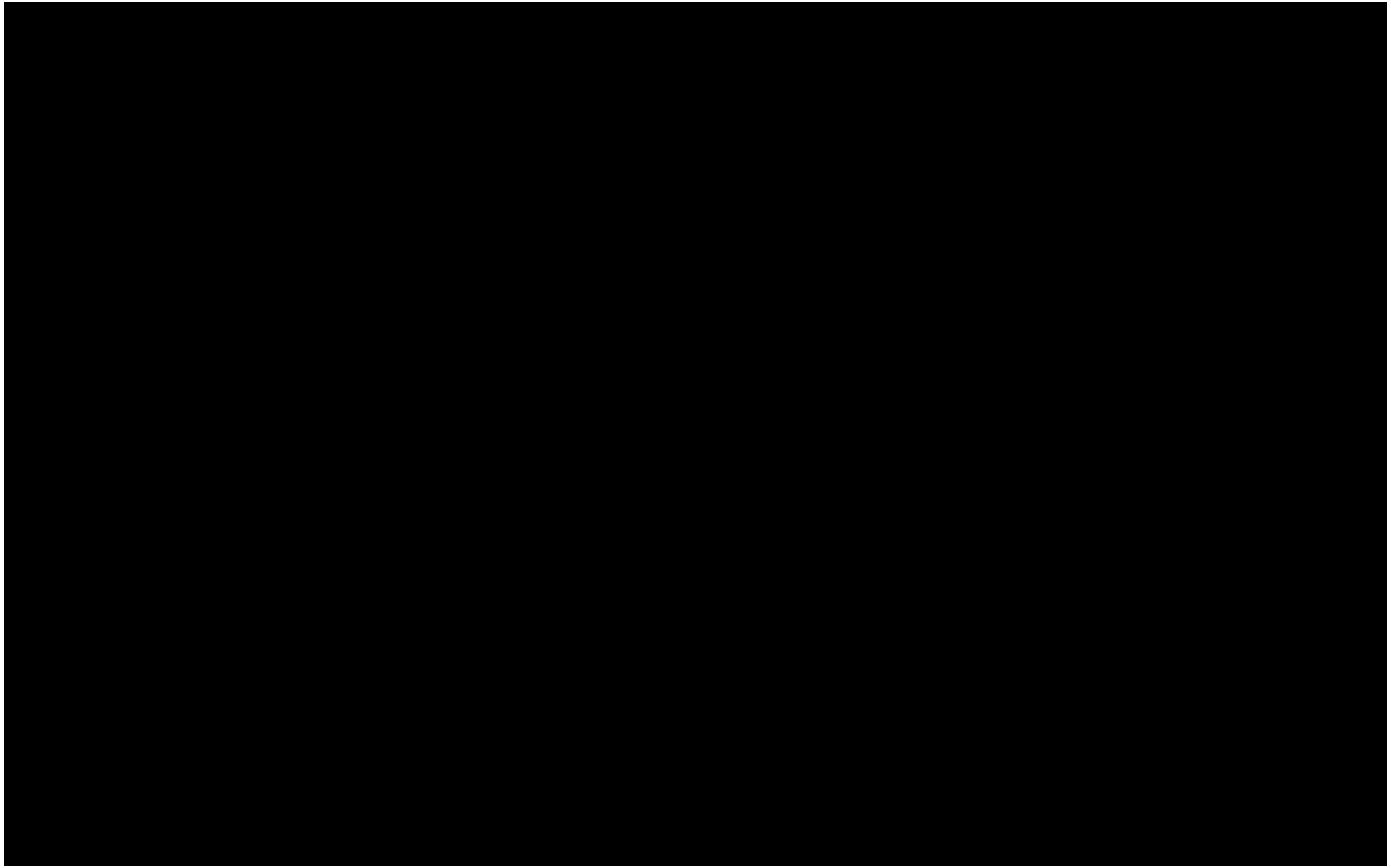
Aboriginal Business

Working Together

[redacted]

Emergency Services

Managing Native Title Holder Money



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QUESTIONS?

Appendix N.1.2 25 231026 Email & presentation

From: Matt Kernke
Sent: Thursday, 26 October 2023 3:48 PM
To: [redacted]
Cc: Tamboran Contact; Emily Beresford-Cane
Subject: Tamboran work program presentation material
Attachments: Tamboran November NTH Work Program Presentation 261023.pdf

Hi [redacted]

As discussed, please find attached a copy of Tamboran Presentation material for next weeks work program meeting with Native Title holders. We will also be talking to our general story boards during the meeting- you would have seen these previously.

Please let me know if you have any issues or concerns- happy to discuss and make the relevant changes as appropriate.

Kind Regards
Matt

Matt Kernke
Environment and Approvals Manager

tamboran
RESOURCES

[redacted]

tamboran
RESOURCES

Draft NLC-Tamboran Beetaloo Joint Venture Project Work Program Meeting

November 2023

Confidential

AMUNGEE NW2H PAD, NORTHERN TERRITORY AUSTRALIA

Agenda

1. About Tamboran
2. Beetaloo exploration
3. [redacted]
4. 2023 work completed/underway
5. Proposed 2024 work program
6. Appraisal gas sale
7. New sacred site clearances
8. Approvals
9. Community projects
10. Near term opportunities
11. Water monitoring update
12. Next steps and Questions

About Tamboran

Introducing Tamboran

We are a publicly listed Australian company with our headquarters in Sydney and staff across Australia and the USA. We are committed to creating value for our shareholders, communities, Territorians and Australians by appraising and developing the gas resources of the Beetaloo Basin. We strive to follow and exceed the example set by Origin in community engagement since 2014 and will continue to focus on economic, development and employment opportunities for Native Title Holders and local communities.

Our Vision

To play a role in the global energy transition by investing in the development of low CO2 unconventional natural gas resources in the Beetaloo Sub-basin of the Northern Territory of Australia and to become a Net Zero carbon emissions gas producer for our equity share of Scope 1 and Scope 2 emissions when the Company achieves commercial gas sales.

Strategy

- Target is to become a Net Zero equity Scope 1 & 2 emissions producer
- Focused, high growth Beetaloo strategy
- High quality assets with significant scale
- Low-cost development targeting multiple markets, premium pricing
- Expertise in unconventional E&P development

Sustainability

- Health & Safety
- Climate Change
- Environment
- People
- Community
- Economic Sustainability

Beetaloo Exploration Project

tamboran RESOURCES

Tamboran Resources, together with joint venture partners Daly Waters Energy and Falcon Oil and Gas, is exploring for gas in the Northern Territory's Beetaloo Basin.

The Resource Potential

Our exploration project in the Beetaloo Basin is a multiyear, shale gas project that started in mid-2014. So far, the Beetaloo Joint Venture (previously led by Origin) has drilled seven wells. All within regulations and with the consent of the pastoralists and Native Title holders.

We plan to drill bring a new drilling rig in to Australia this year (2023), which will be used to drill between 2-6 wells for the next 2-3 years.

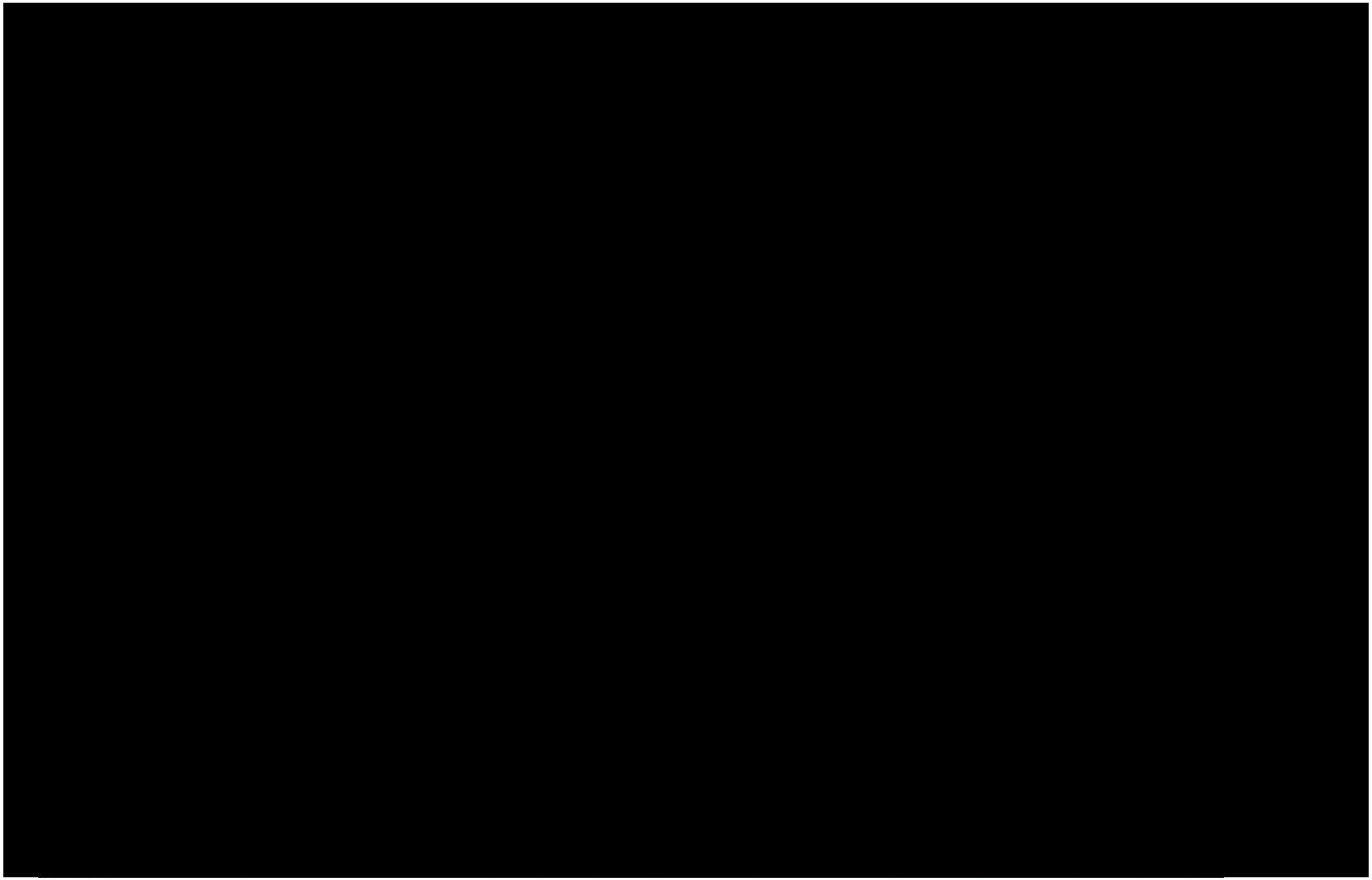
We think there's a very large gas resource underneath the ground with outstanding potential. Today our project has as much as 61 trillion cubic feet of gas, with 6.6 trillion cubic feet of that already recognised as a contingent resource*. Just how big is this? The Inpex project is 12 trillion cubic feet and the Mereenie gas fields have produced around 240 billion cubic feet since the mid 1980's.

* Amungee well estimate

The Benefits

If successful, and development goes ahead, the project means:

- more work for and jobs with local companies, including Aboriginal companies
- the opportunity to supply goods and services to the project
- financial payment for host pastoralists and Native Title holders
- taxes and royalties – providing government with more money that can go to improving community services, infrastructure and telecommunications
- energy security (delivering gas to the Eastern Australia)



Operations update – 2023 program summ

Amungee NW 2H well testing completed

- Well achieved gas breakthrough- with skin believed to have reduced production rates

H&P rig mobilised to site

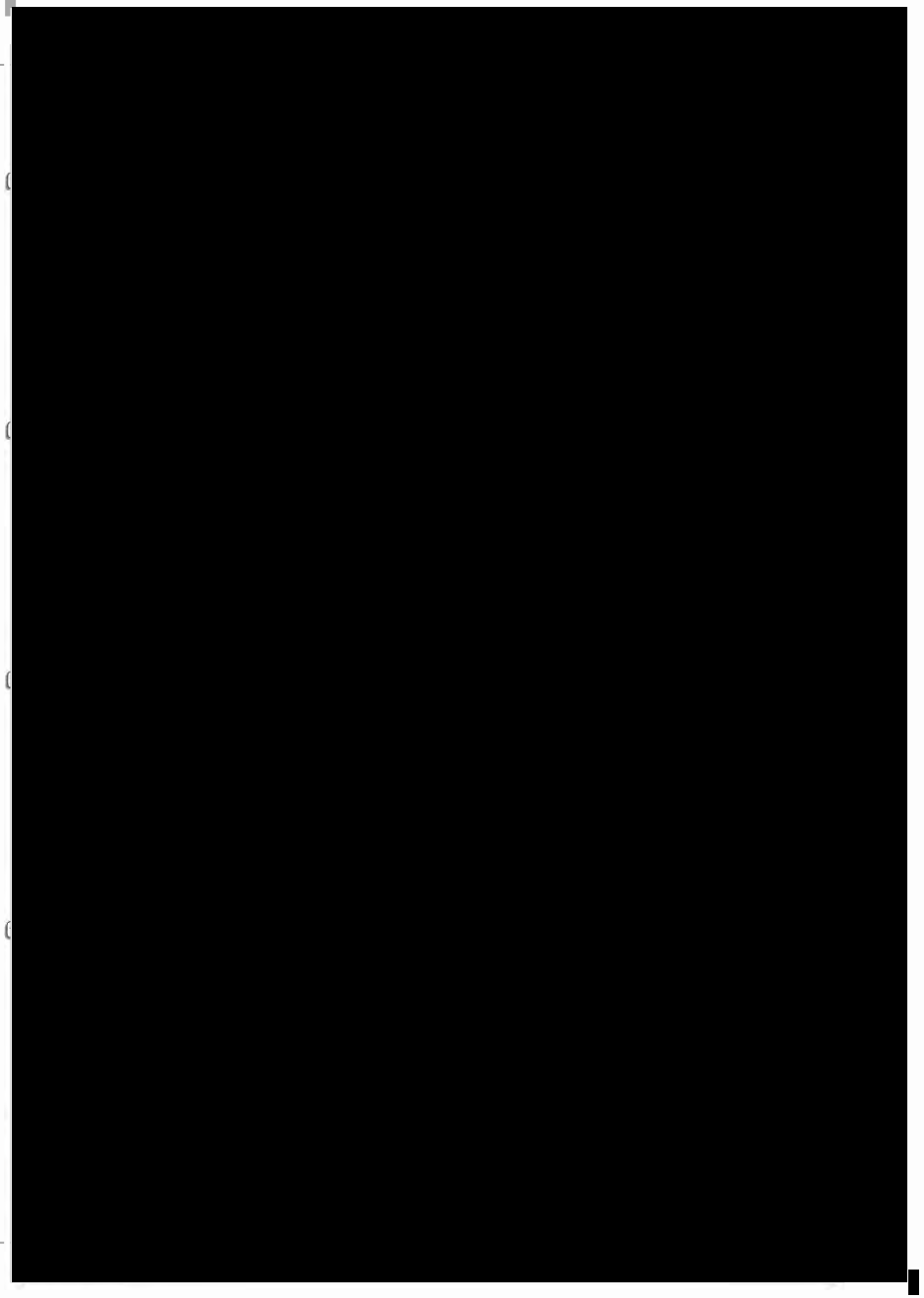
- The H&P super-spec FlexRig® Flex 3 Rig was successfully mobilised into the Basin bringing modern US drilling technology to the Beetaloo Basin

Shenandoah South 1H well drilled

- The SS1H well successfully intersected 90 metres of high quality Mid-Velkerri B Shale, the thickest section to date within the Beetaloo Basin
- Stimulation and well test planned for November 2023

Amungee NW 3H well drilled

- Well successfully drilled and cemented in less than 18 days, the fastest well drilled to Total Depth (TD) with a horizontal section into the Mid Velkerri B Shale to date.
- Stimulation and well test planned for Q2 2024



Indicative 2024 program

Continued focus around Amungee NW and Shenandoah South (Kyalla 117 N2)

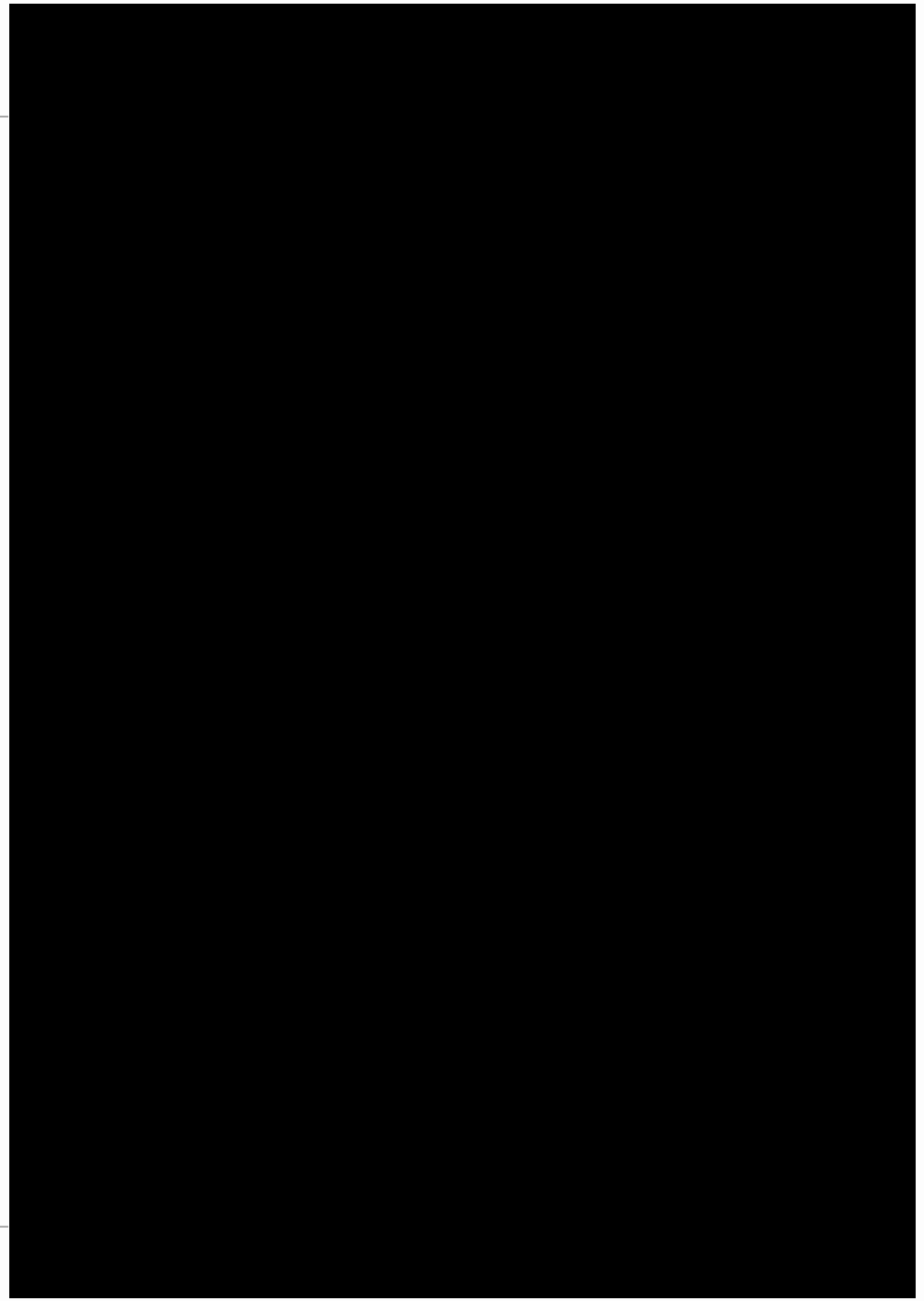
2024 program - pending JV agreement and approvals

- Amungee NW 3H hydraulic fracturing and testing
- 2 additional horizontal wells on the existing Kyalla 117 N2 site and associated pad expansion (drill/frac/test)
- New “Step out” location – Shenandoah S2 – for 2 new wells (civils/water bores/drill/frac/test)

Contingent scope

- 2D/3D seismic program within Shenandoah Sth or Amungee NW Delineation area
- Construction of new location Amungee NW3
- Drilling of 2 additional wells on Amungee NW or Amungee NW3

Tamboran will present our firm 2024 work program in Q1 2024



Appraisal gas

➢Longer term appraisal

- Tamboran needs to flare gas to test the underlying shales
- Future wells will likely require extended testing which will generate greenhouse gasses
- To reduce greenhouse gasses and allow for extended testing- Tamboran proposes to sell appraisal gas via its “Flare Avoidance Project”

➢Appraisal gas sale options

- Locations – likely within Subject land 2 (Shenandoah Sth) and Subject land 5 (Amungee Delineation area)
- Indicative timing – mid-late 2024
- Indicative volumes ~10-40TJ/day depending on well productivity
- Could be via a pipeline and compression facility or through trucking compressed natural gas (CNG)/ liquefied natural gas (LNG) generated onsite
- Schedule imperatives – we seek early indication from NTHs

Other regulatory approvals

Tamboran continues to consult with the NLC in obtaining the relevant approvals required for its Explorational and appraisal Activities. Consultations underway in 2023 include:

- **New Water Extraction Licence** – increase the current WEL level from 175ML/year to 450ML/year
- **Environmental Management Plan-** submission of new EMP covering:
  - 3 new Exploration locations in Shenandoah South (subject land 2)
  - 1 new Exploration location at Shenandoah North A
  - 15 New E&A wells- 14 new horizontals wells and 1 new vertical
  - Gathering lines connecting sites to allow for water and gas transfers

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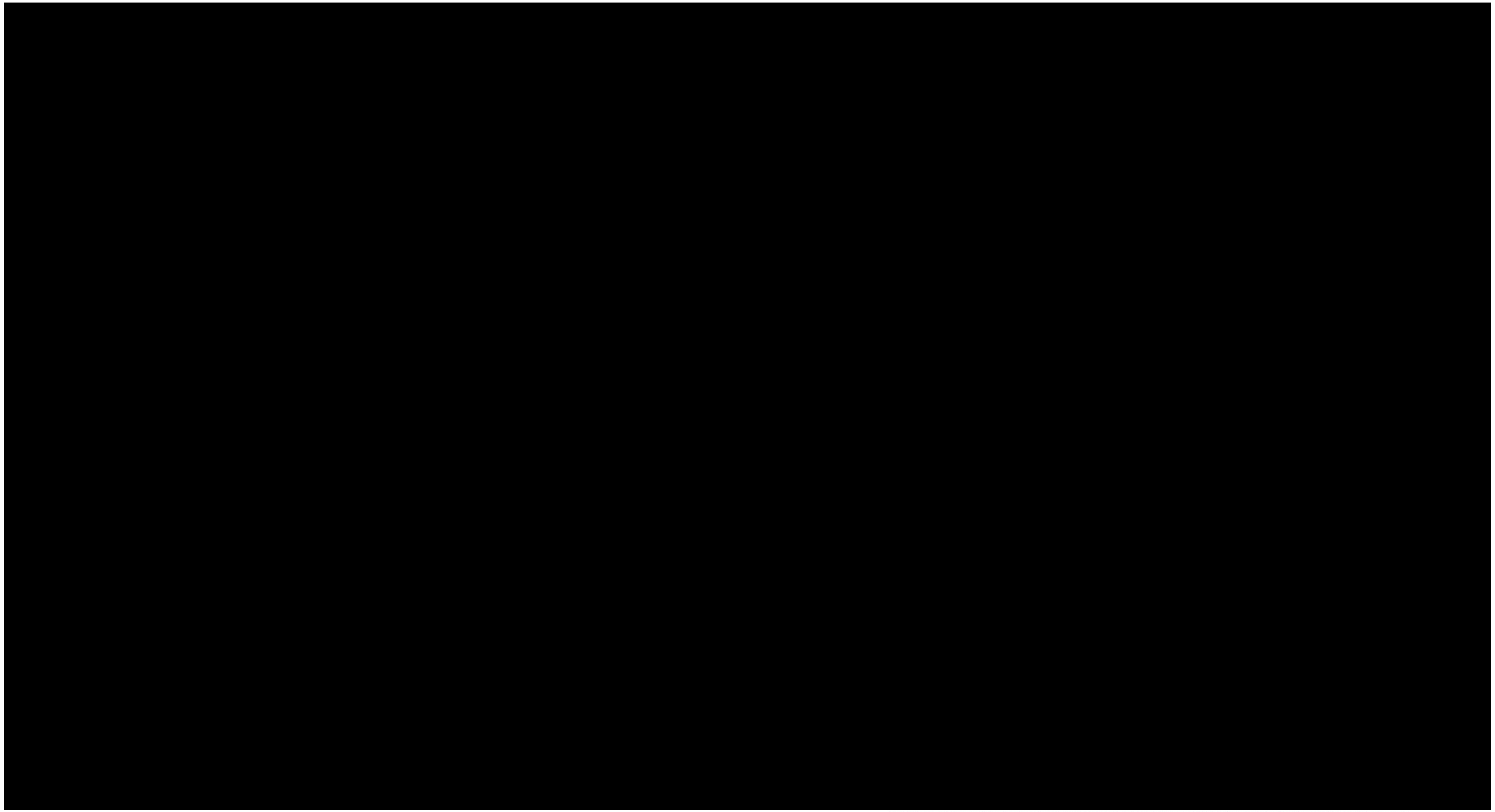
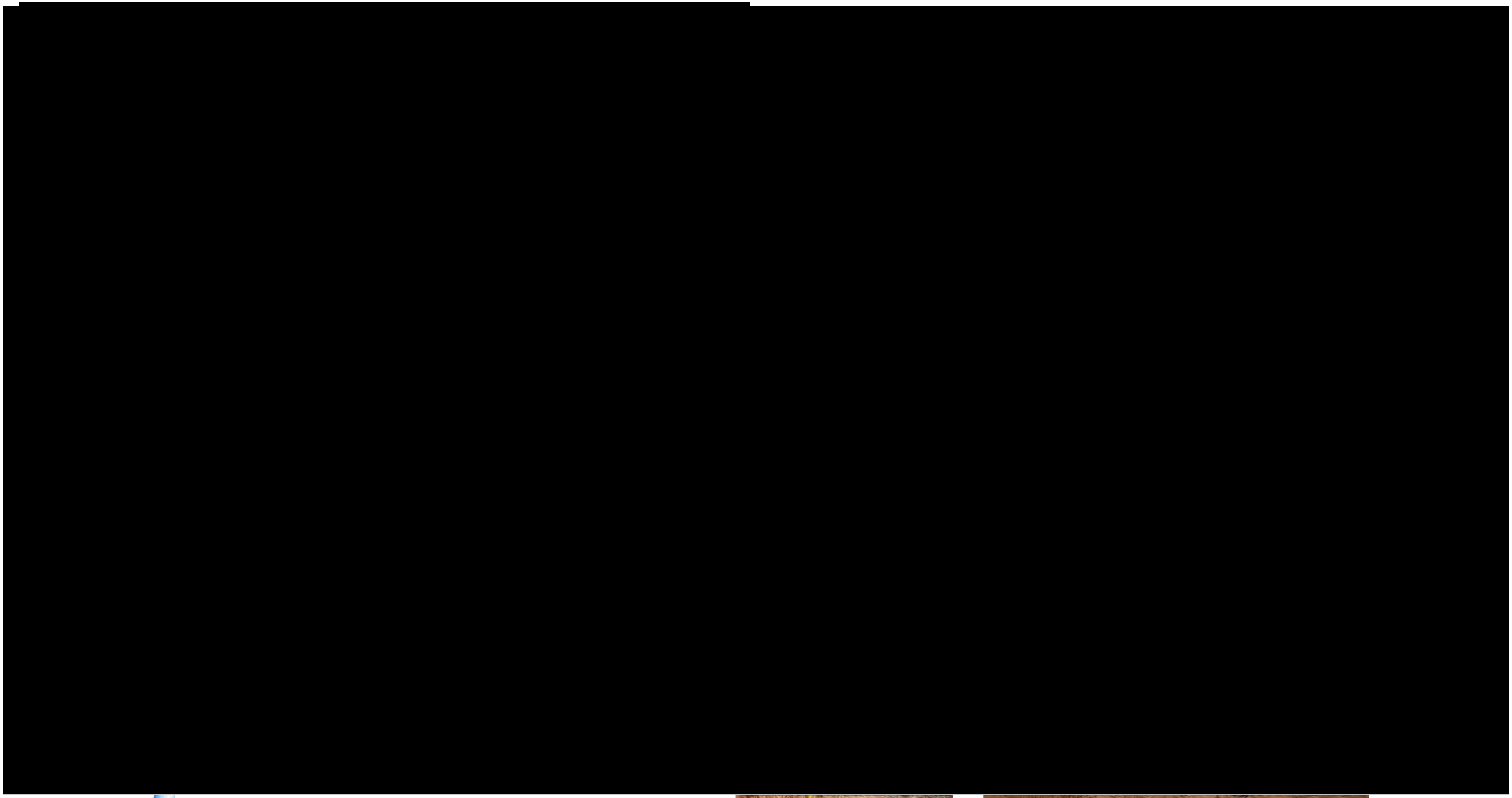
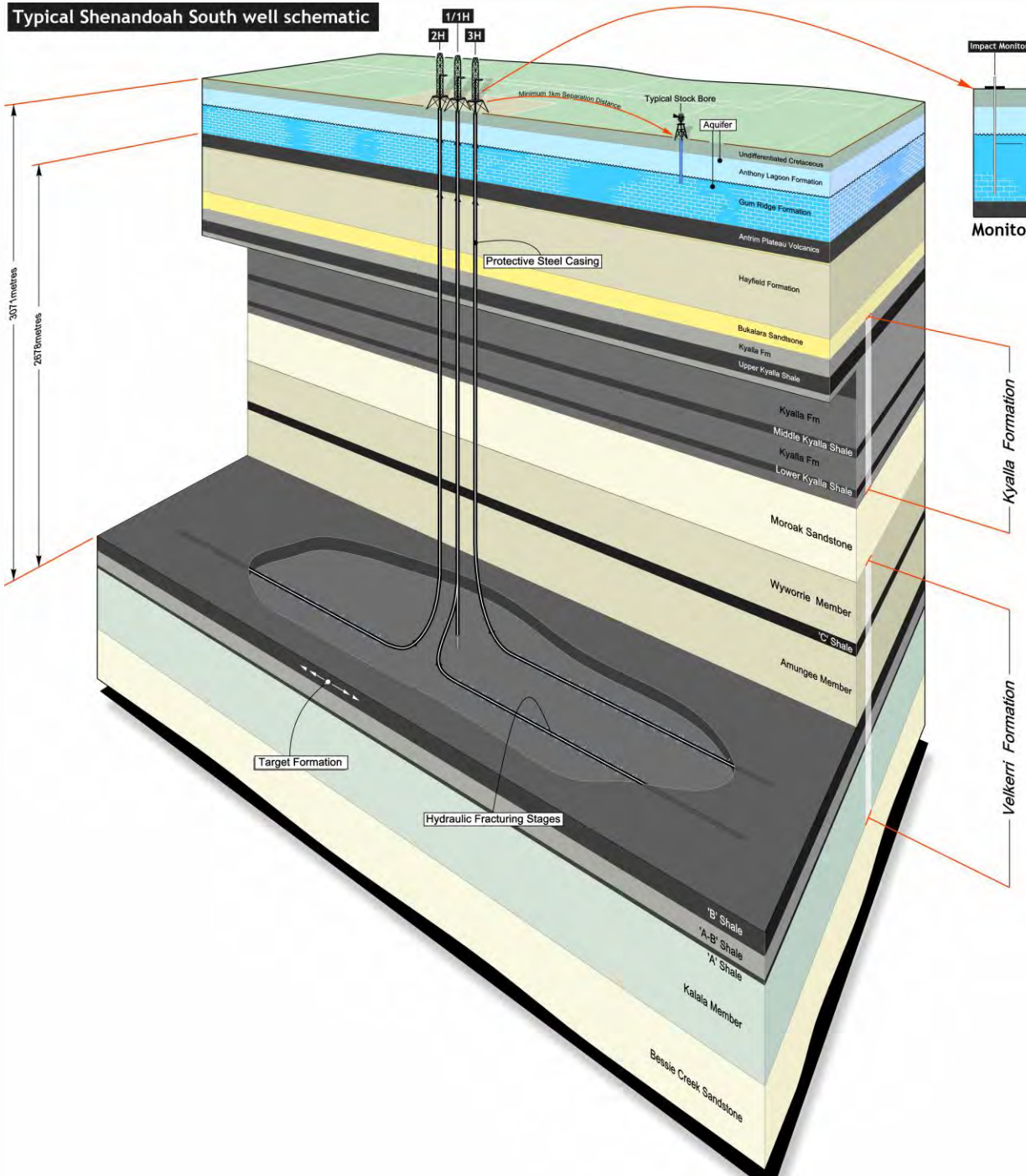
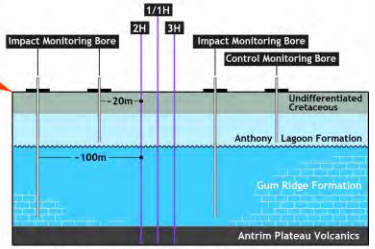




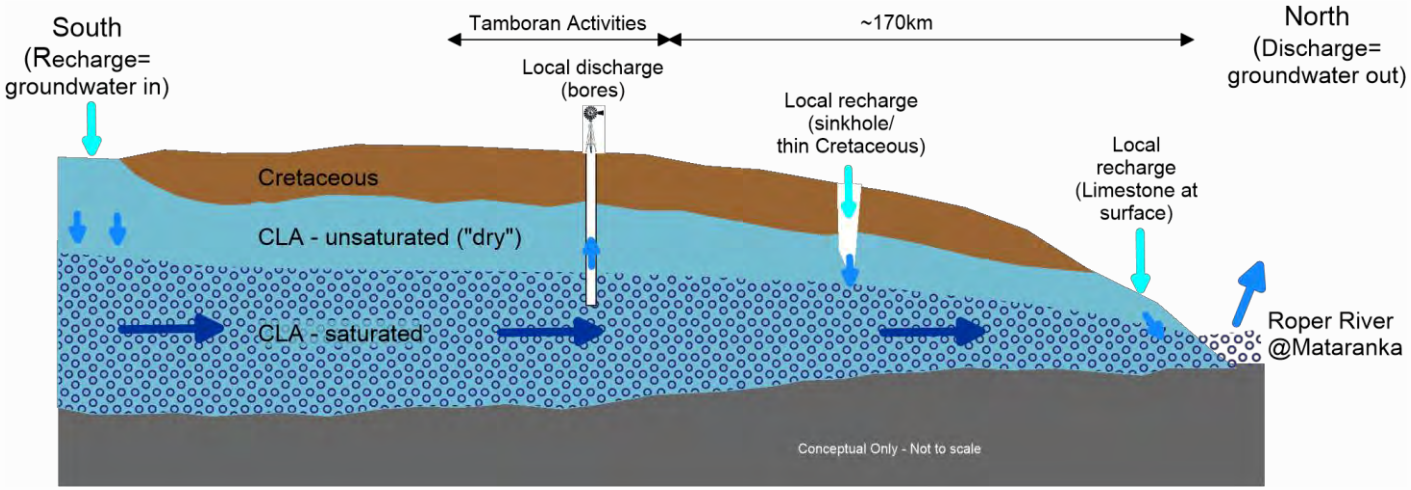
Typical Shenandoah South well schematic

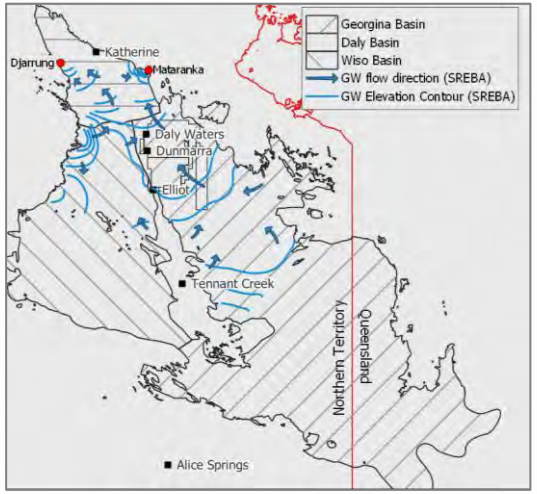




Monitoring Bore Detail

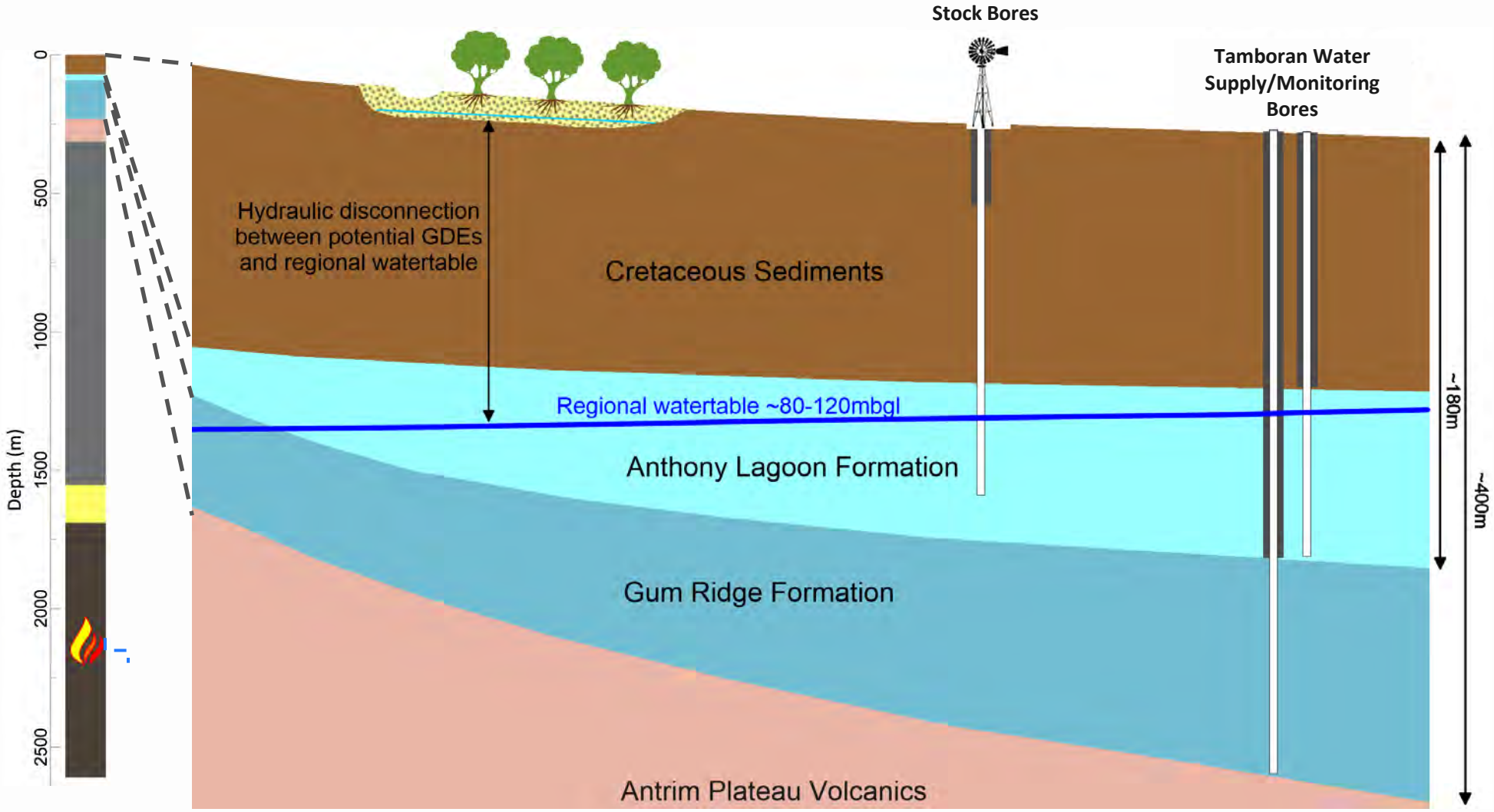
Groundwater in the CLA



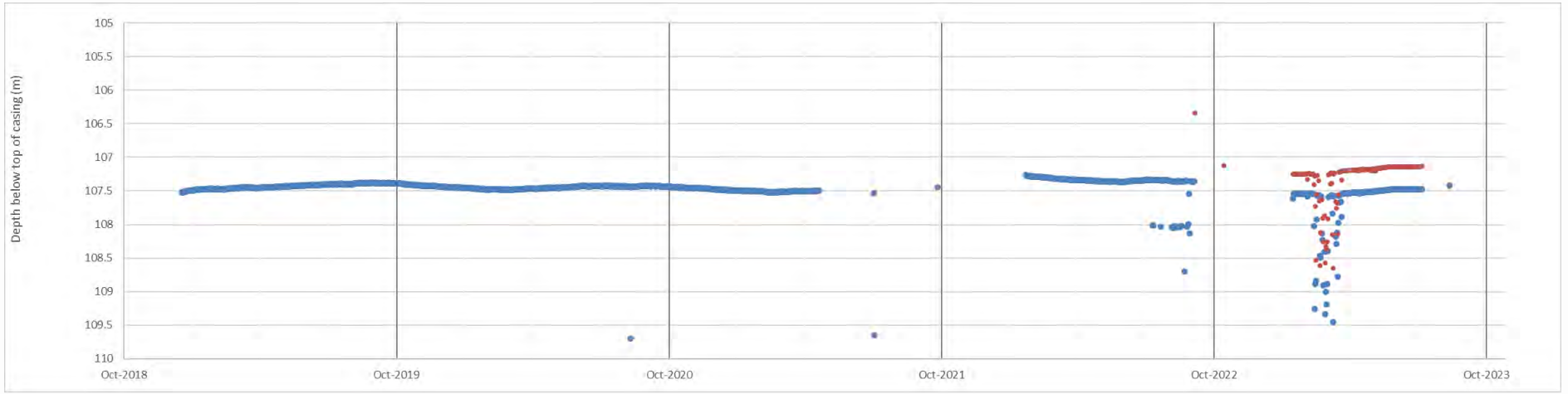


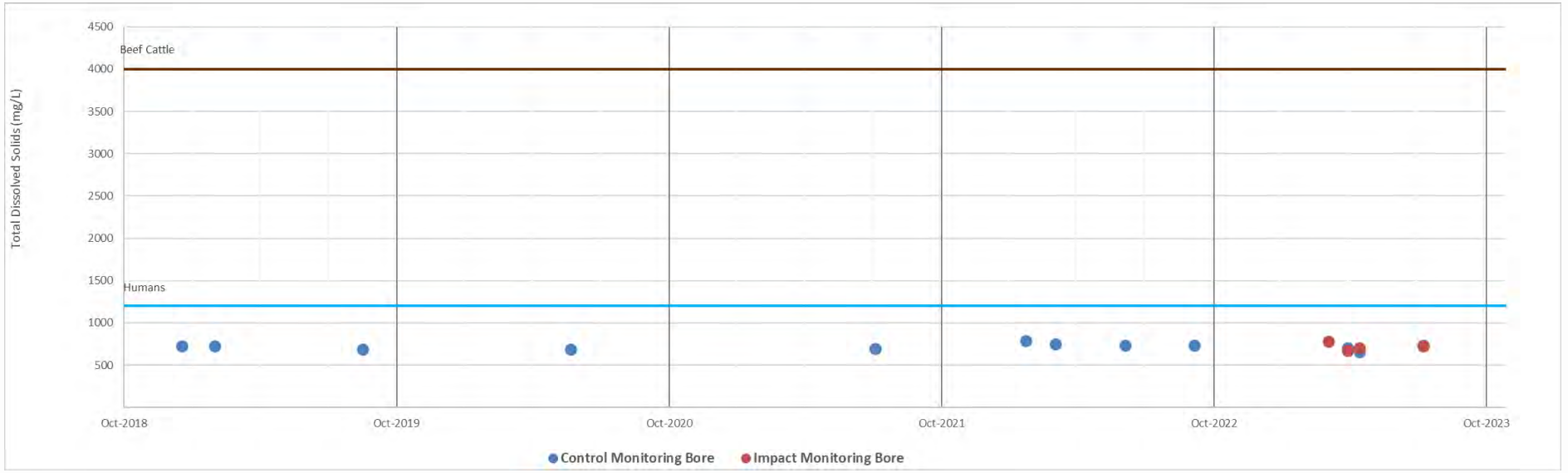
- 1,810,000 – 3,690,000 GL volume of groundwater stored within CLA
- Total usage of ~42 GL/year, Elliott usage ~0.18 GL/year
- Groundwater moves ~0.1 m/year
- Studies indicate that discharge at the Roper River (and Mataranka springs) is sourced from relatively close to the river. Groundwater originating from the CLA within the Beetaloo Sub-basin is likely to be only a very minor portion of the total discharge

Groundwater and surface water

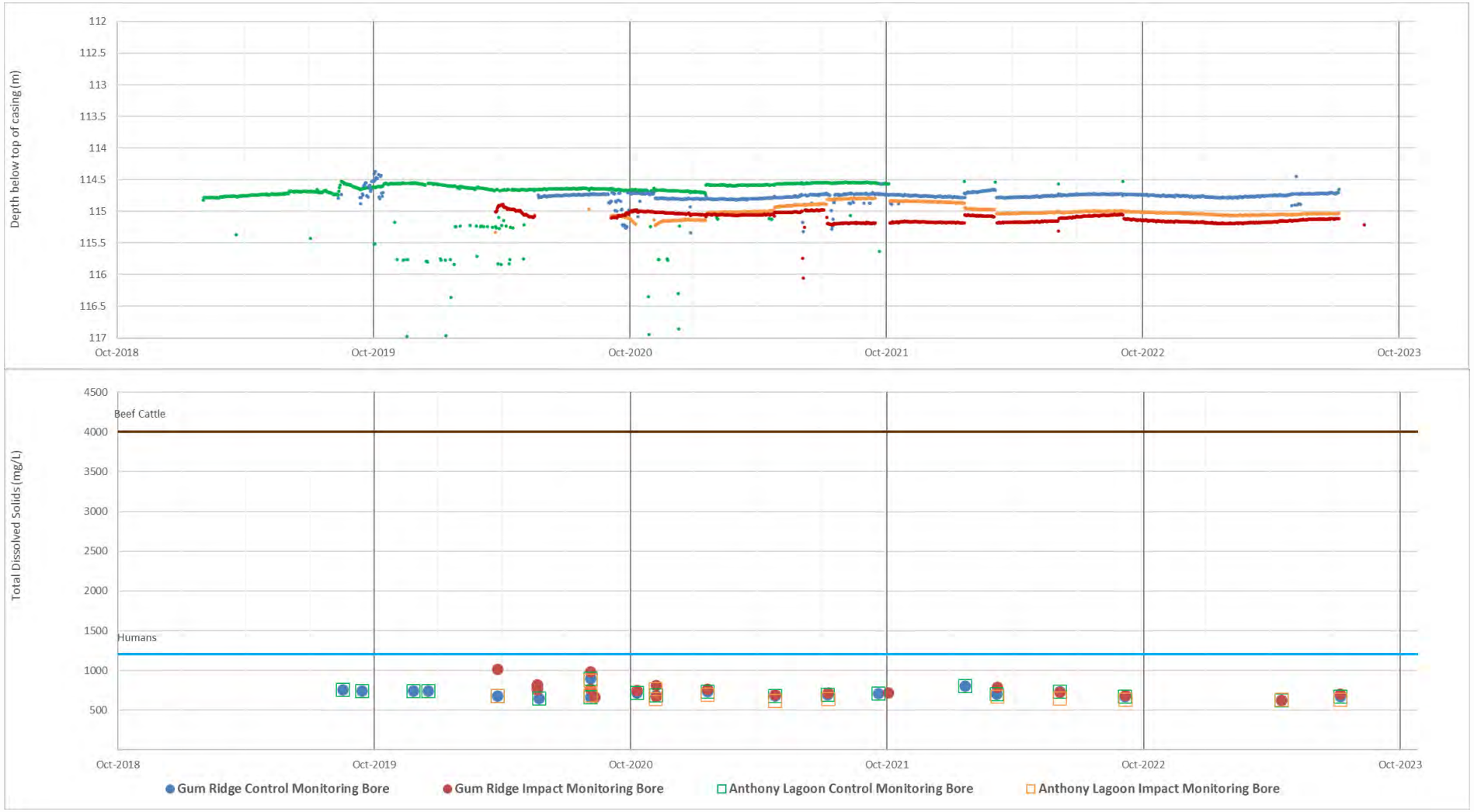


Wellsite Monitoring – Amungee NW

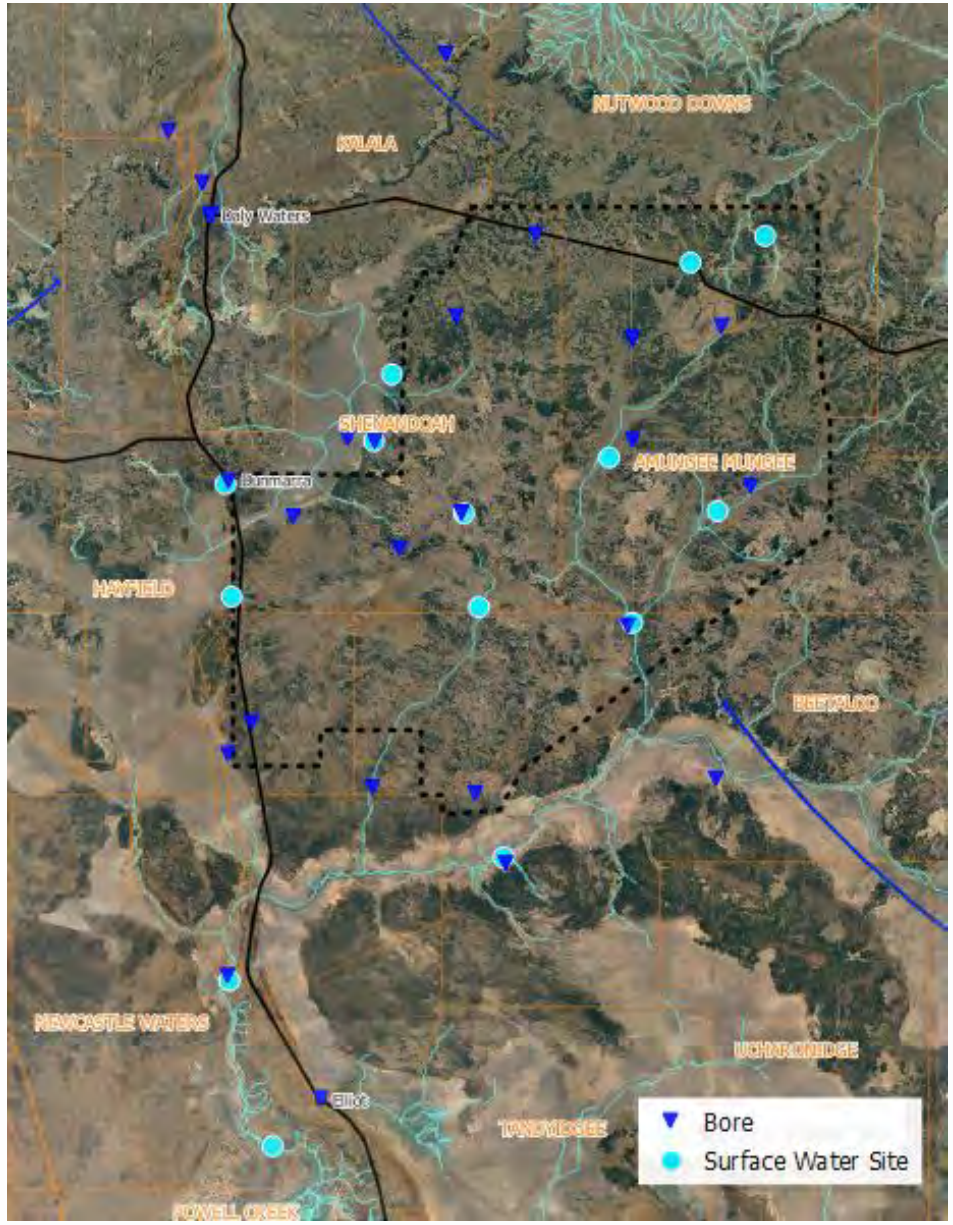




Wellsite Monitoring – Kyalla117



Regional Monitoring Program



QUESTIONS?

Appendix N.1.2 26 231101 Email & presentation

From: Matt Kernke
Sent: Wednesday, 1 November 2023 3:43 PM
To: [redacted]
Cc: Linda Pugh; Tamboran Contact; Emily Beresford-Cane
Subject: Draft Shenandoah south E&A EMP
Attachments: Tamboran NLC EMP summary.pptx

Categories: Yellow category

Dear [redacted],

As foreshadowed, please find attached a copy of the draft Shenandoah south E&A EMP and associated Appendices in the below link. The Document is quite large and therefore has to be sent via a link.

I have also included a summary presentation to provide information on h wo this fits in to our broader strategy and some of the key themes.

Please note, we are making some final updates and some of the content may undergo minor changes (such as wastewater balances).

We will be looking tom submit this shortly and any feedback prior to and during the DEPWs assessment process can be accommodated (similar to previous submissions).

I will touch base with you next week about any comments you have.

Kind Regards
Matt

NLC

Matt Kernke
Environment and Approvals Manager

tamboran
RESOURCES

[redacted]

Tamboran Beetaloo Joint Venture Project
Shenandoah South E&A Program Environment Management Plan

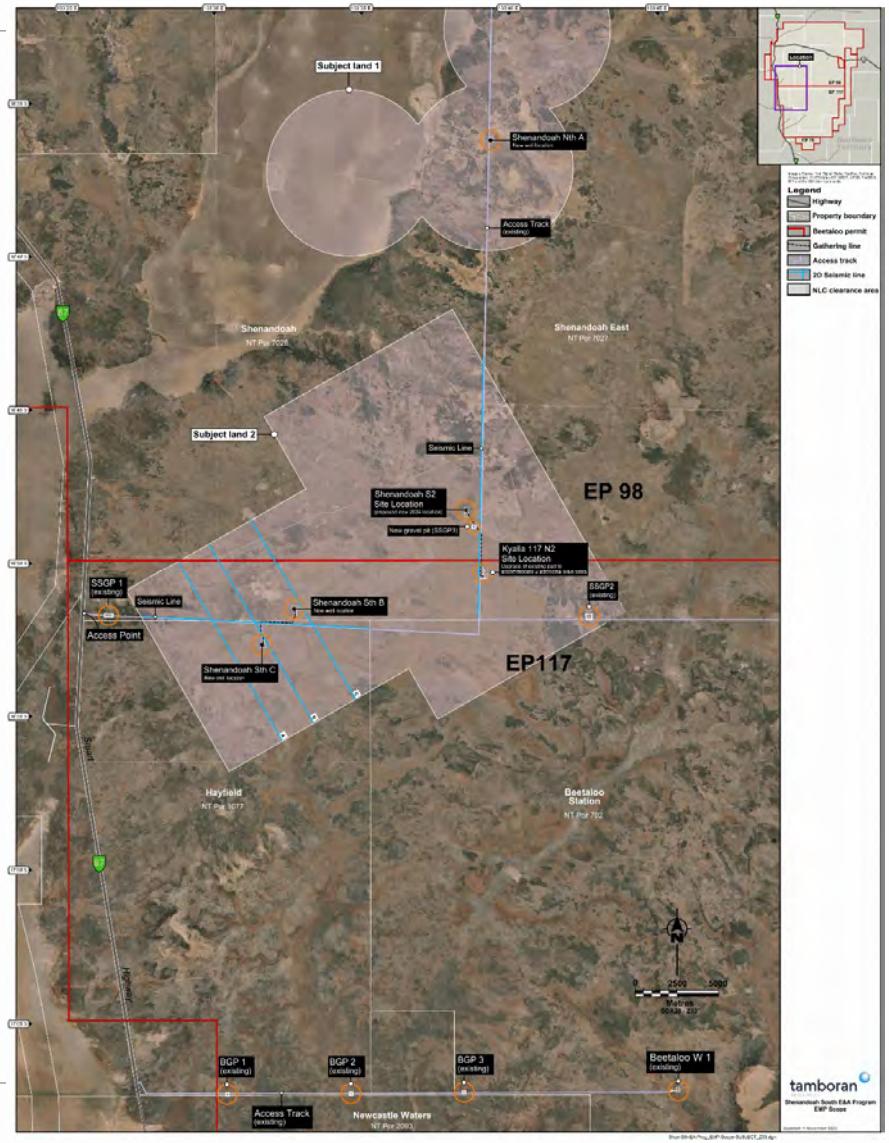
November 2023

Confidential

AMUNGEE NW2H PAD, NORTHERN TERRITORY AUSTRALIA

Shenandoah South E&A Program EMP

- Tamboran proposes to submit a new Environment Management Plan (EMP) covering a series of future regulated activities on 117 and EP 98.
- The EMP is referred to as the Shenandoah South E&A Program EMP
- This EMP covers a range of potential activities that are subject to the results from the Shenandoah S-1H well and regulatory approvals
- Activities include:
  - Subject land 2:
    - 2D seismic program
    - Existing Kyalla 117 N2 location
    - 3 new exploration locations (including lease pads, camp pads, access tracks etc.); Shenandoah S B, Shenandoah S C and Shenandoah S2
    - 15 new horizontal E&A wells in subject land 2
    - Gathering lines connecting sites to allow for water and gas transfers
  - Subject Land 1
    - 1 new exploration location at Shenandoah North A (subject land 1)
  - Existing Beetaloo W (Cleared in 2014 and 2018)



Results to date- the where and why

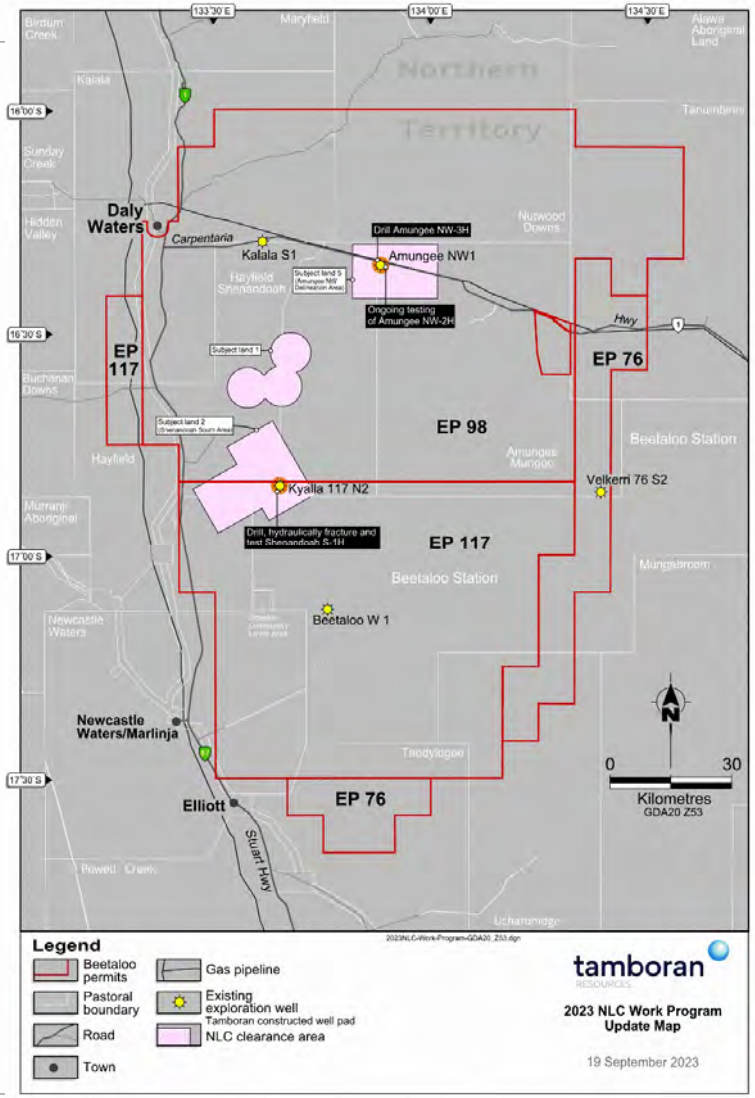
- Tamboran is currently focusing its exploration strategy on 2 main areas; Shenandoah south Pilot Area (subject Land 2) and Amungee Nw Delineation Area (subject land 5)

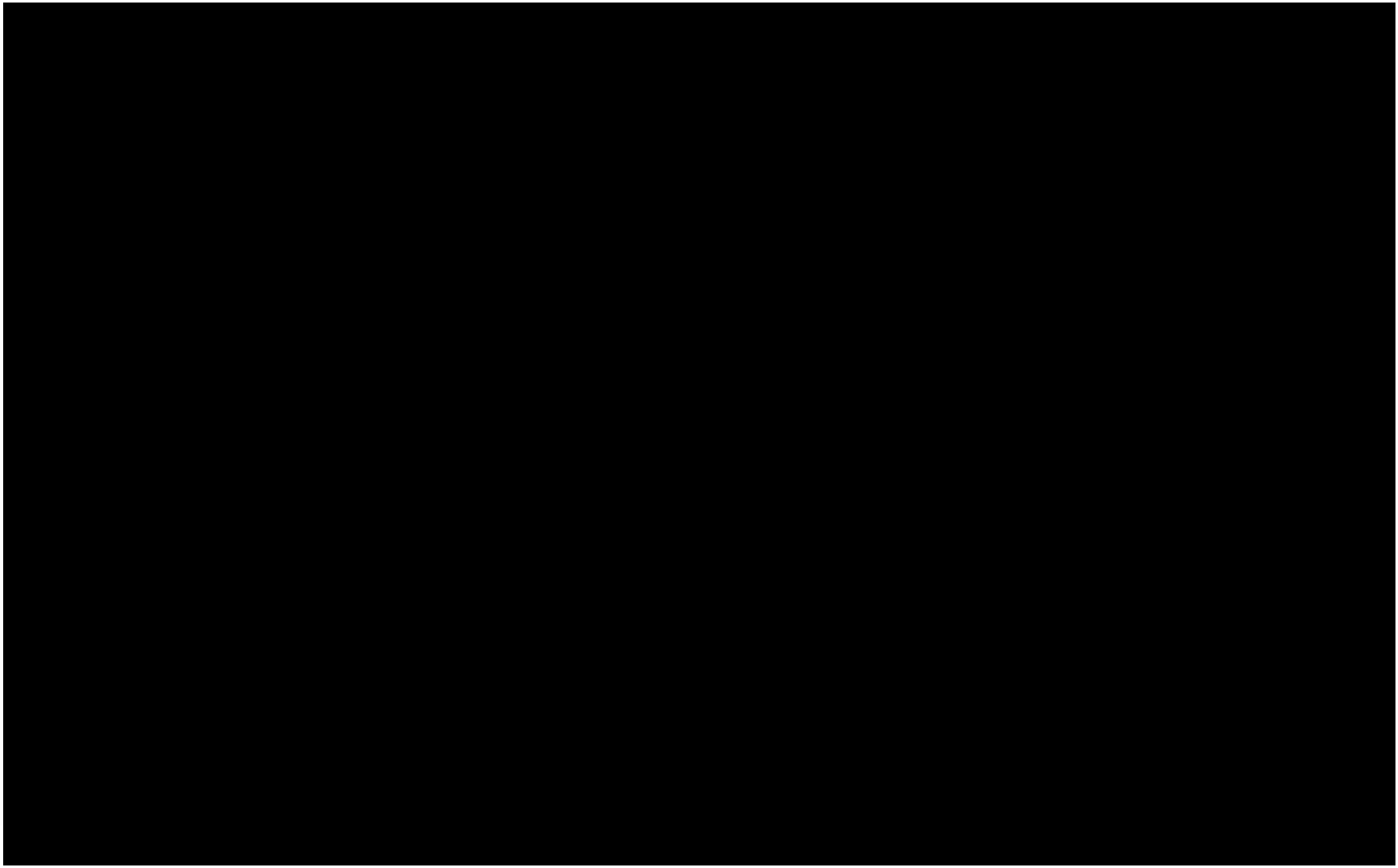
Shenandoah South EA Area (Subject Land 2)

- The Shenandoah S-1H well was successfully drilled in 2023 and intersected 90 metres of high quality Mid-Velkerri B Shale, the thickest section to date within the Beetaloo Basin
- Stimulation and well test planned for November 2023
- A positive well test result will increase the activity in this area- those activities are covered under the proposed Shenandoah South E&A Program EMP

Amungee NW Delineation EMP (Subject Land 5)

- Amungee NW stimulated in 2016 prior to moratorium
- Well test results confirm at a production rate equivalent to 5mmcfd/ 1000m lateral (extremely good)
- Amungee NW 2H well drilled in 2022 and stimulated in Q1 2023- results were disappointing and believed to be a fluid compatibility issue resulting during stimulation (Aka “skin impacts”)
- New Amungee NW 3H well drilled in October 2023, with simulation in Q2 2024.
- Stimulation and well test planned for Q2 2024
- Pending results form both this well and Shenandoah S-1H- focus on the Amungee Delineation Area could increase in 2024 (i.e if Shenandoah s-1H underperforms and Amungee NW 3H achieves expectations).
- Existing Amungee Delineation EMP covers sufficient activity within subject land 5 for any future activity.





Key environmental aspects and controls

Groundwater protection

- All wells designed and constructed with multiple strings of cement and casing to protect aquifers
- Barriers tested for integrity prior to stimulation- if they don't pass- we don't frack
- Monitoring of groundwater completed before, during and after stimulation for a period of 3 years
- All groundwater take licenced under a Water Extraction Licence- which has assessed the sustainability of the take

Sacred site avoidance

- Petroleum exploration activities are located away from sacred sites to avoid impacts-
- All sites are cleared by NTH's for sacred sites through annual sacred site clearance requests
- Cultural managers are employed to confirm site location, including any changes
- Restricted Work Areas (RWA's)are signed, with access prohibited
- Inductions contain information regarding RWA's and sacred site proteciton

Wastewater Management

- All flowback wastewater is stored in double lined tanks with leak detection
- Enclosed tanks and large freeboards are utilised to prevent tank overflows
- All flowback wastewater storage areas are bunded to prevent oversight releases
- We test all stormwater prior to release- this ensures its not contaminated
- All sumps are lined, with onsite disposal of drilling cuttings/ muds only permissible where safe to do so (an independently verified)

Spill prevention

- All chemicals, fuels and contaminants must be stored with secondary containment
- Routine checks are required to ensure the integrity of the secondary containment
- A spill management plan has been developed and must be implemented.
- All spills are required to be reported and cleaned up immediately

Greenhouse gas emission management

- We are required to flare to determine how much gas can be produced
- Appraisal gas sale will be prioritised in the future to reduce GHG emissions (not the subject of this EMP), with engagement with NTH's underway
- Appraisal gas sale will reduce wasted gas and scope 1 GHG emissions by ~80%.
- We minimise venting
- Leak detection programs are completed on all wells to detect and repair leaks

Land Clearing and management

- We avoid clearing during the December to March period
- Spotters (Cultural Managers) will be used during clearing to relocate fauna
- Clearing of riparian vegetation is avoided- there are no major creeks or rivers in our proposed area
- An Erosion and sediment control plan has been developed and will be implemented
- Each site has a bushfire management plan, with n flaring/ grinding during fire bans and asset protection zones used to prevent fires impacting
- All vehicles and equipment must be clean and certified free of weeds before entry into the basin

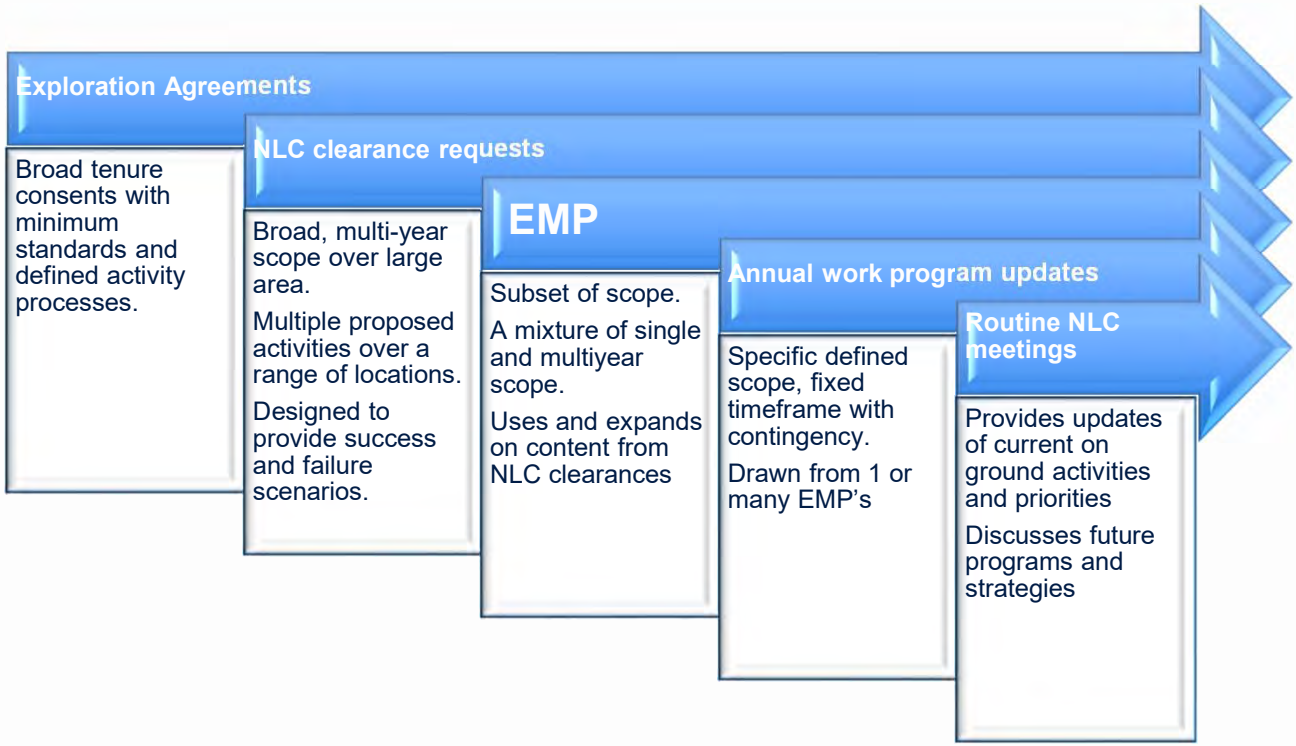
Rehabilitation

- Tamboran is required to hold a security bond with the NTG to cover all financial liability associated with it's activities
- All sites will be return to a safe, stable, non-polluting form, consisting with the pre-disturbance condition
- Monitoring is completed post rehabilitation, with sign off form the government required prior to getting our bond back

Stakeholder Engagement

➢**Engagement of proposed activities has been completed by the following mechanisms:**

- **Exploration agreements**
- **Annual work program and sacred site clearance requests**
  - ➢ Annual work program and sacred site clearance request submitted to NLC on 16 of January 2023- Covers subject Land 2 and extension
  - ➢ 2019 and 2021 Work Program clearance request (November 2019 and September 2021) – cover proposed activities within subject land 2
  - ➢ 2014 Work program and NLC cite clearance (submitted June 2014)- covering Beetaloo W-1
- **Routine meetings with NLC to discuss current and future scope**
- **A Draft EMP is attached to this presentation- however the level of engagement through this document is considered poor due to size , type of content and different intent.**



Next Steps

- Tamboran is currently finalising the EMP and is planning to submit this to DEPWS shortly
- We ask that information pertaining to this proposed EMP be kept confidential, until it is formally lodged
- Assessment of the EMP will take approximately 90-120 days- including a 28 days public consultation period
- Tamboran is happy to walk through any of the content with the NLC and where appropriate (and material), changes to the document can be accommodated.

Appendix N.1.2 27 240202 Tamboran reponses to NLC re EMP

From: Emily Beresford-Cane [redacted]
Sent: Friday, February 2, 2024 5:13 PM
To: [redacted]
Cc: [redacted]
Subject: Correspondence regarding Tamboran's Environmental Management Plan

Dear [redacted]

Please find **attached** correspondence regarding the Tamboran Beetaloo Basin Shenandoah South E&A Program EP98 and EP117 EMP.

Matt Kernke, Tamboran's Environment and Approvals Manager, will be in Darwin on Tuesday 6th February and is available to meet the NLC to discuss the contents of the **attached** and answer any further questions the NLC may have in relation to the Environmental Management Plan.

Please don't hesitate to give me a call if you have any questions.

Have a great weekend.

Emily

1 February 2024

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[redacted]

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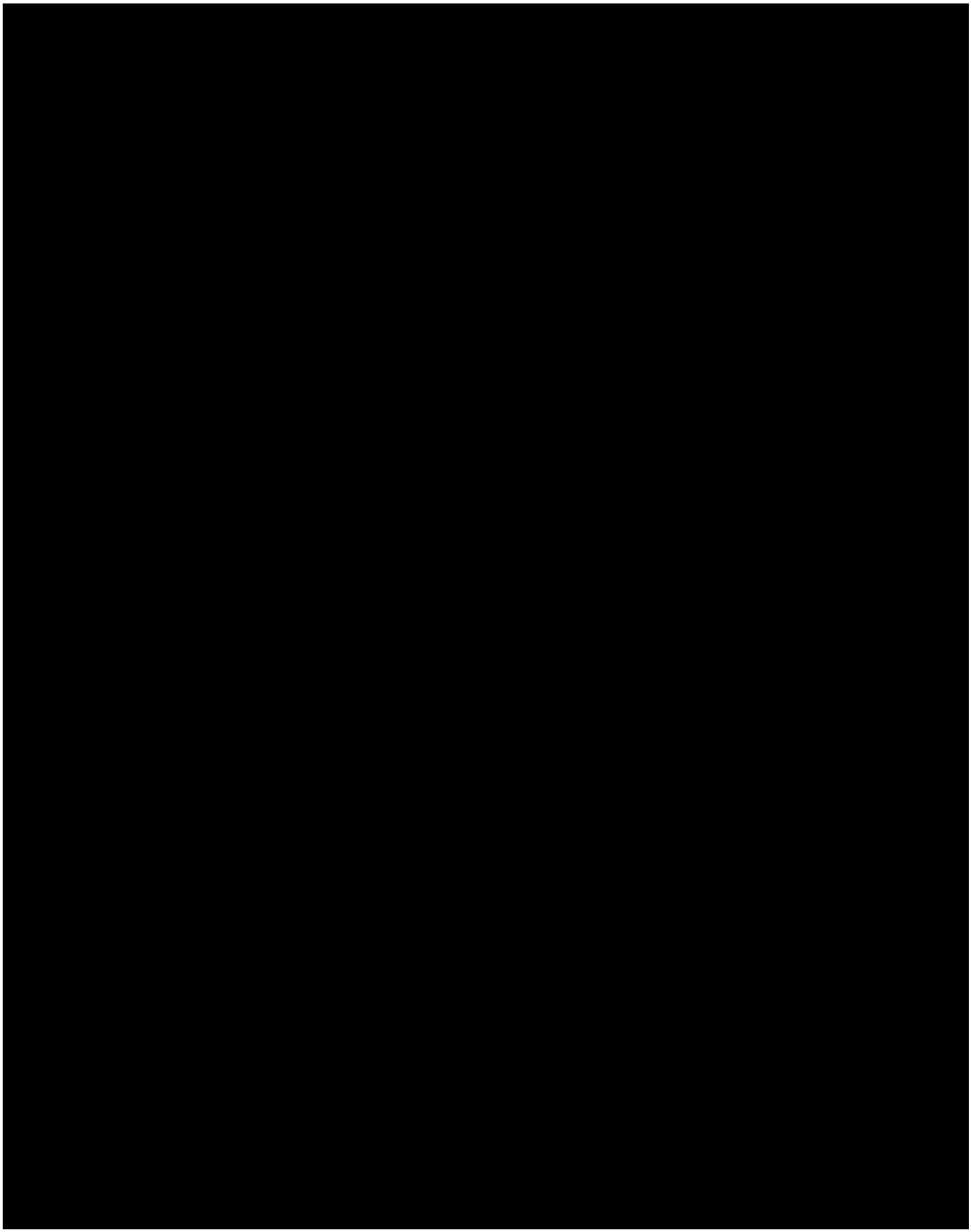

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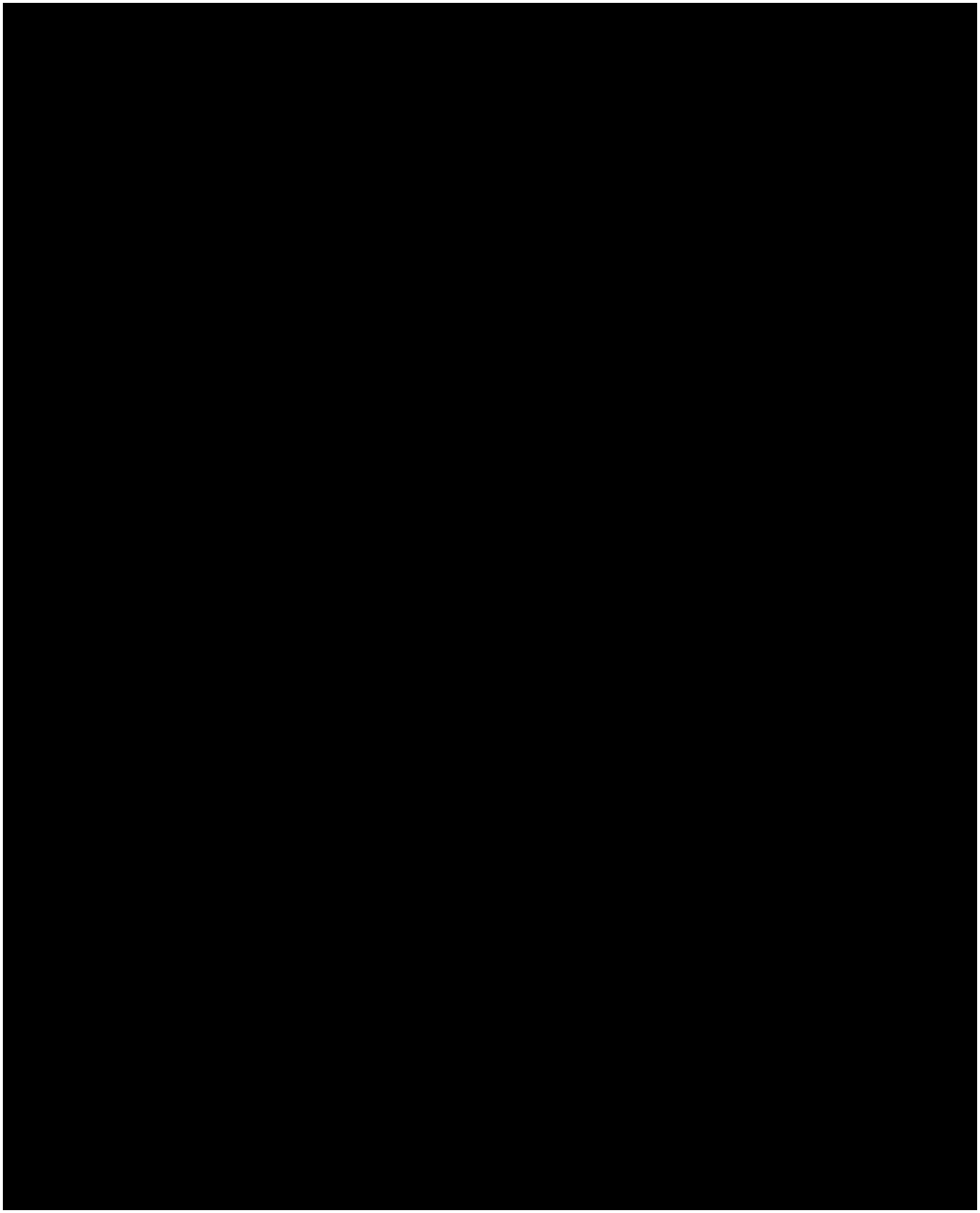

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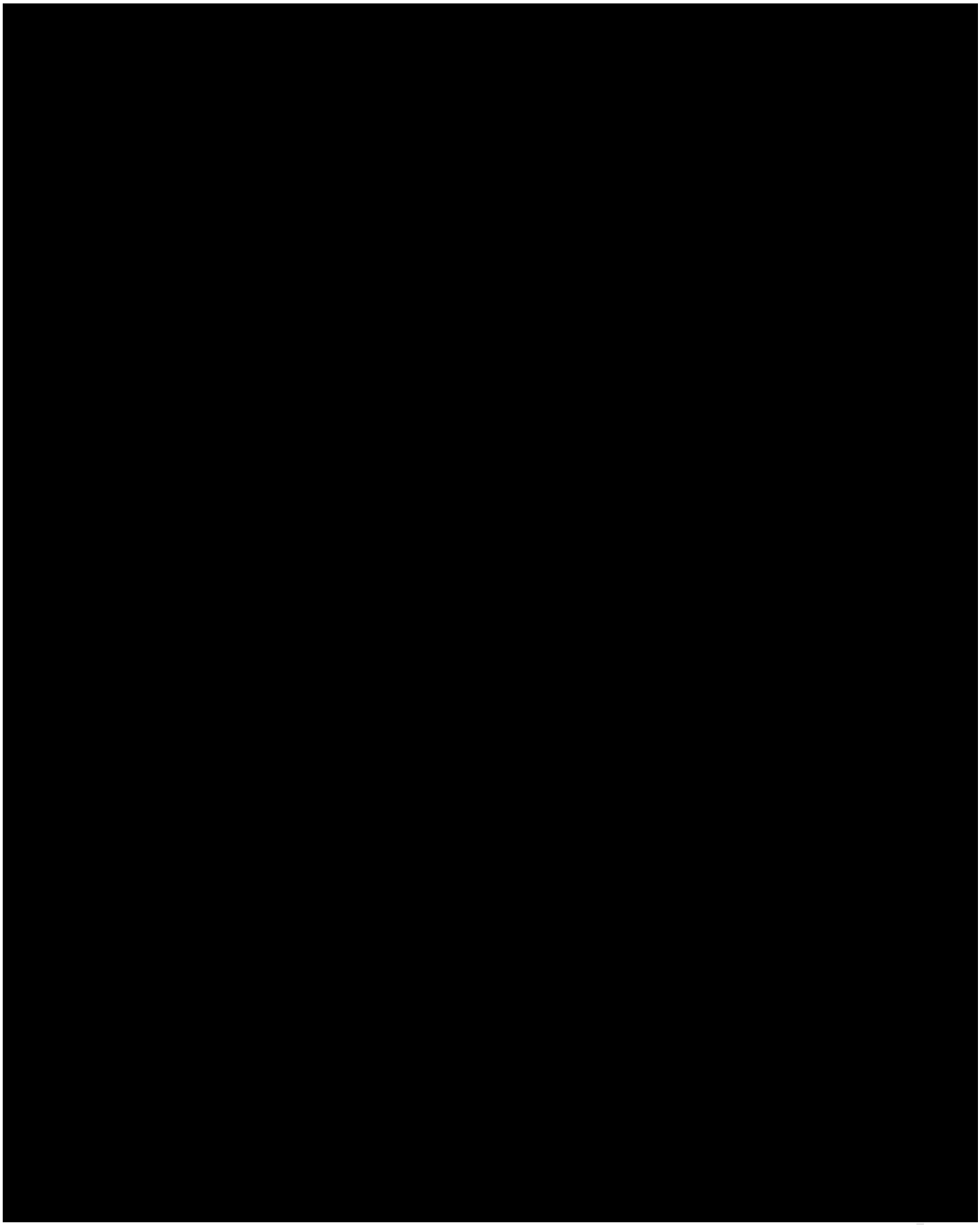

[redacted]

Yours Sincerely,

Emily Beresford-Cane

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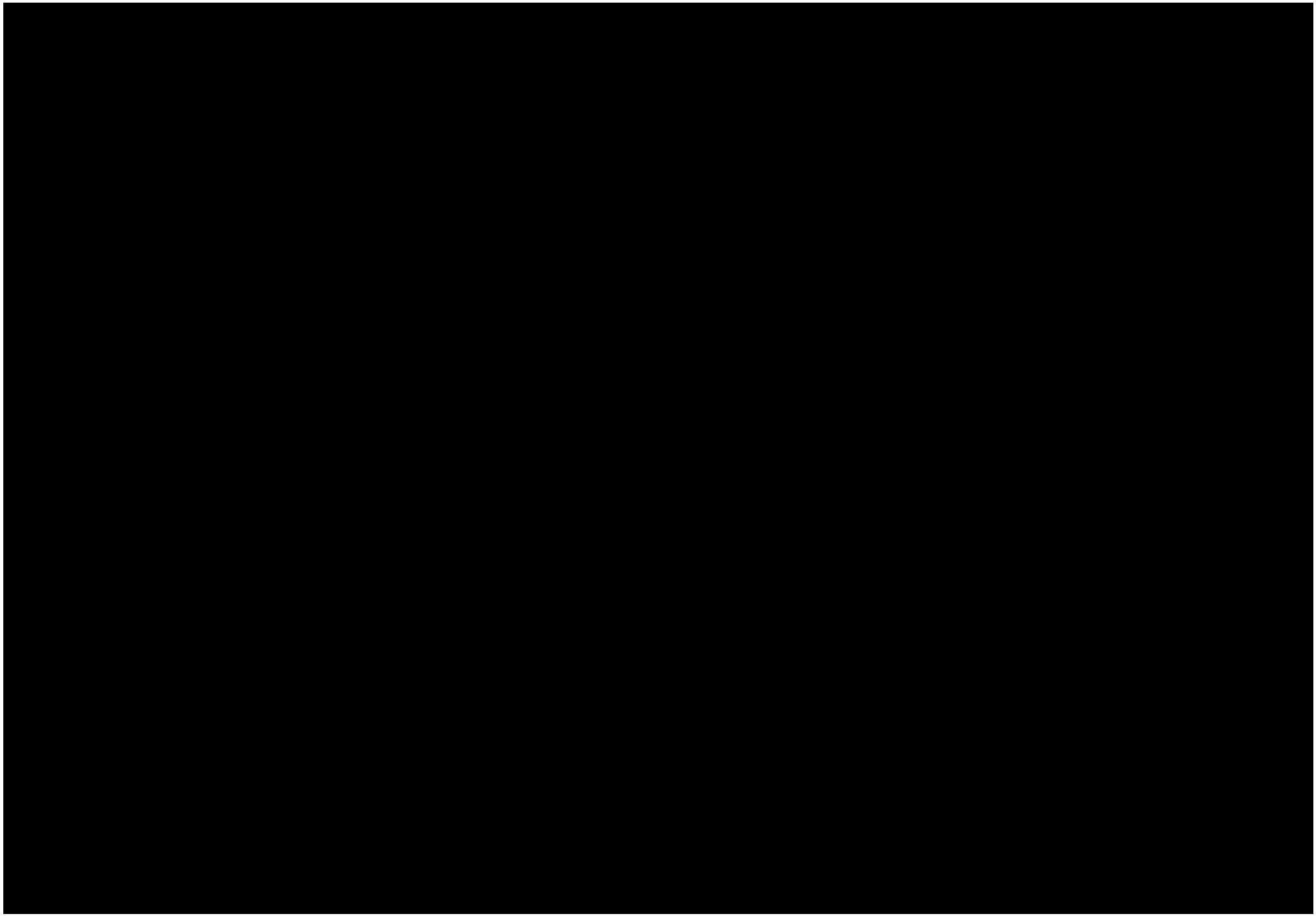

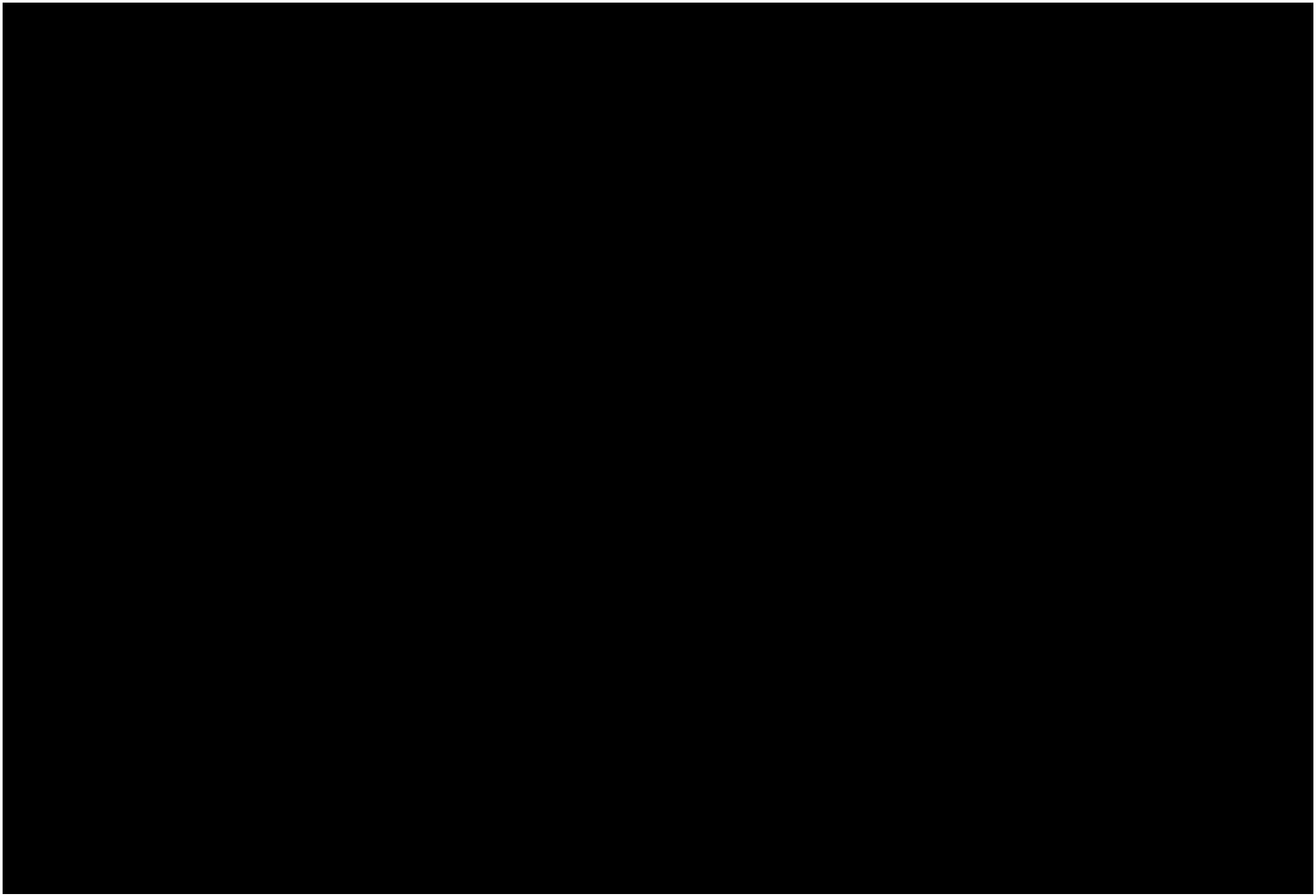

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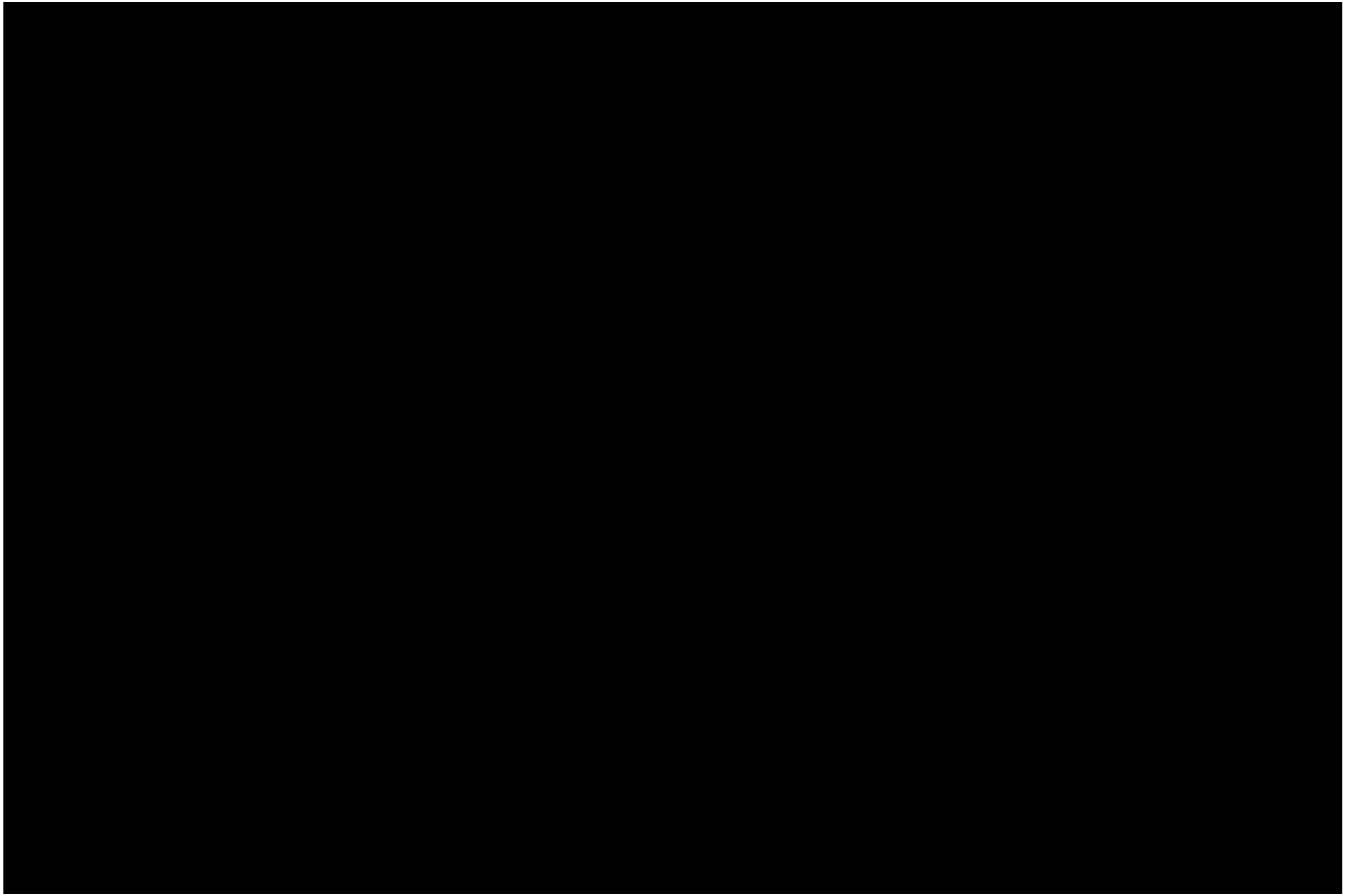

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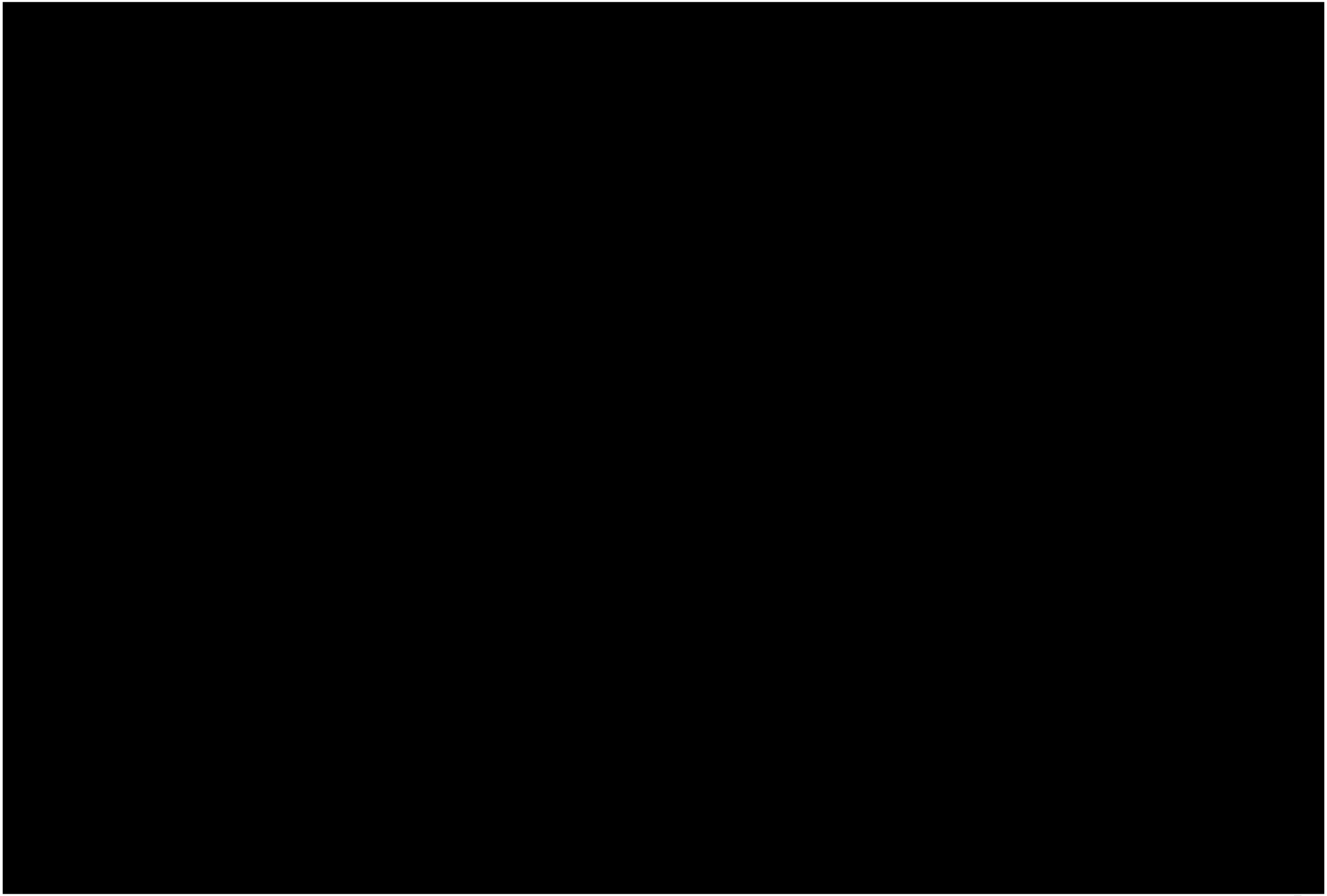

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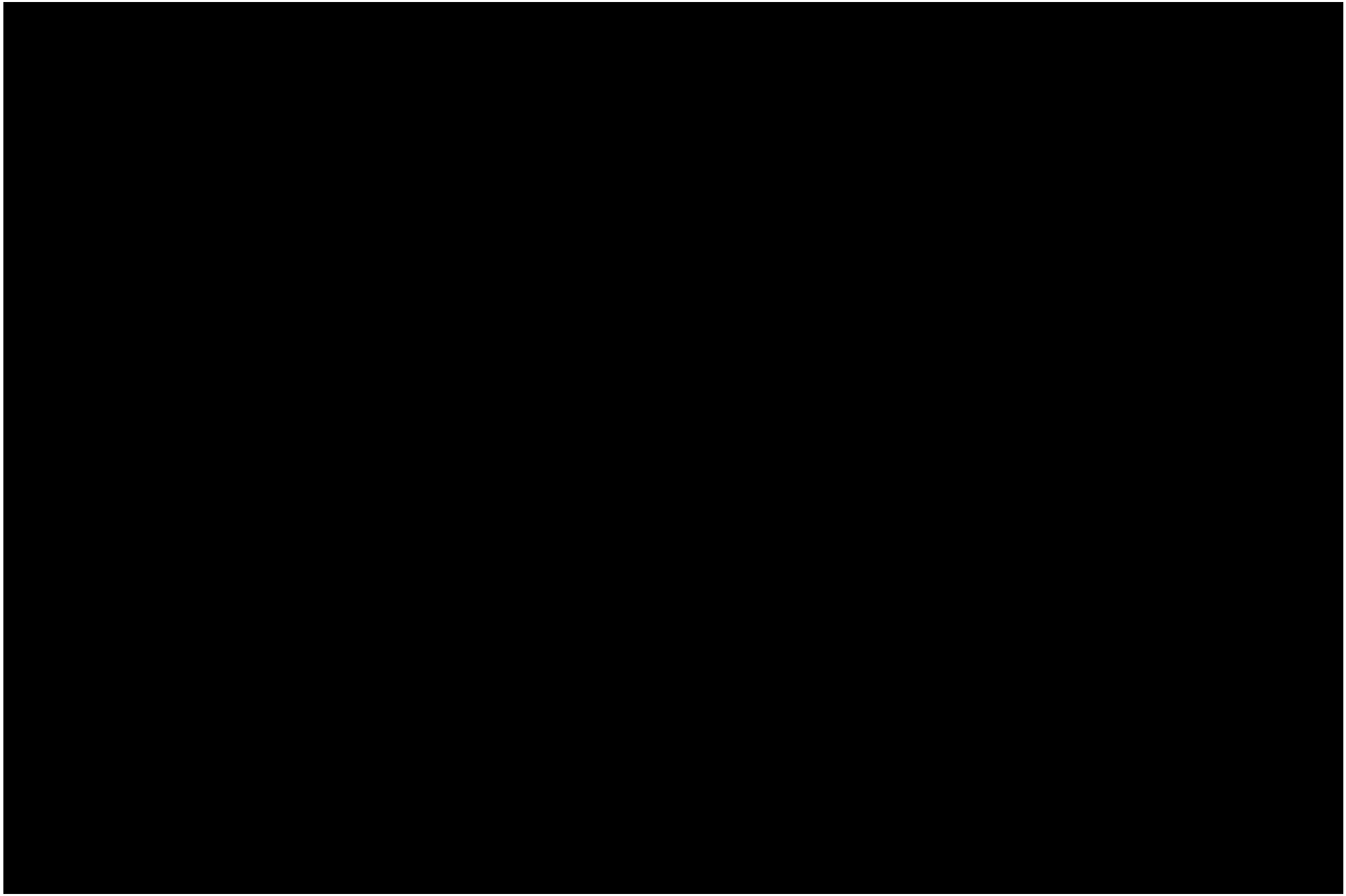

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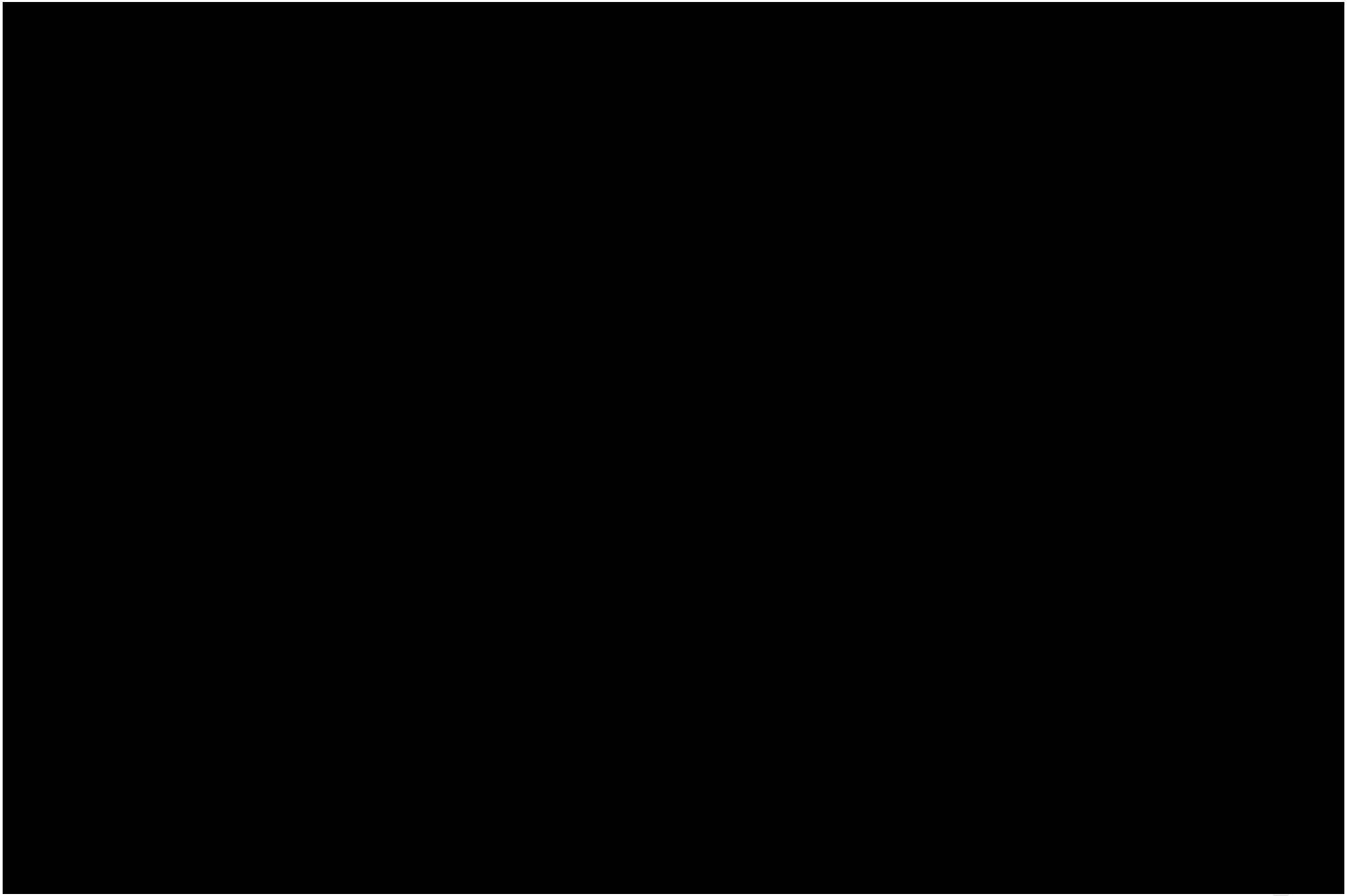

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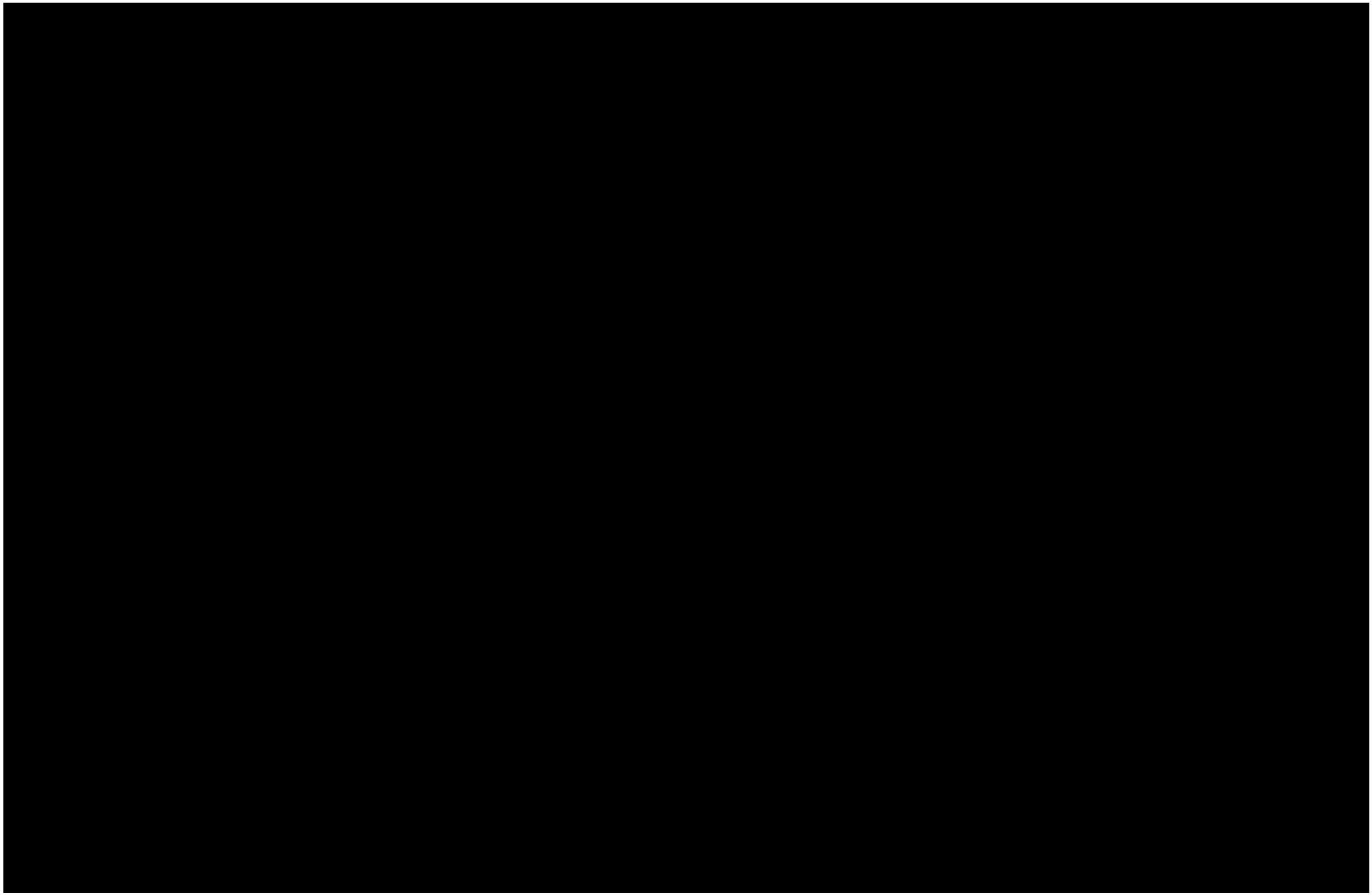

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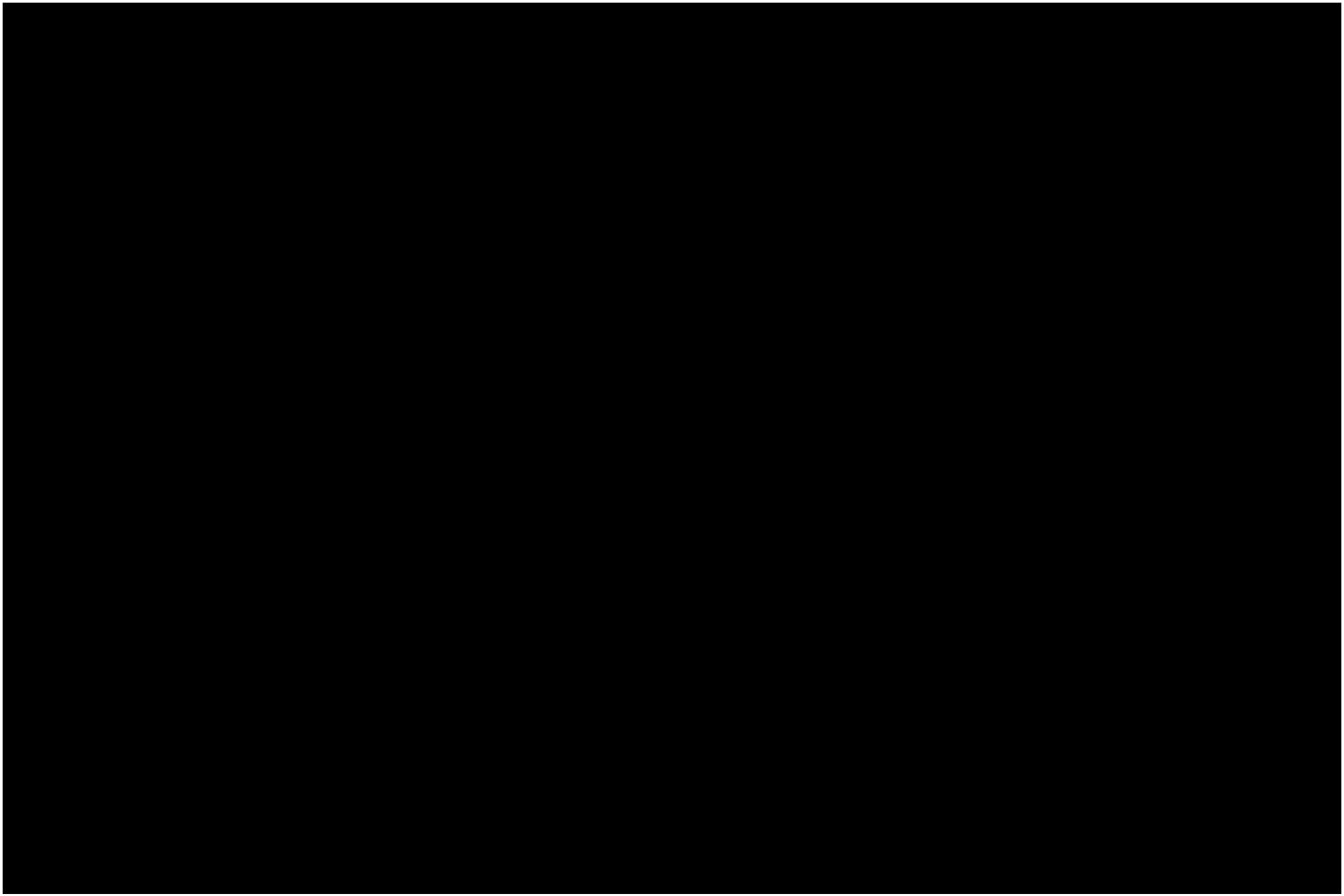

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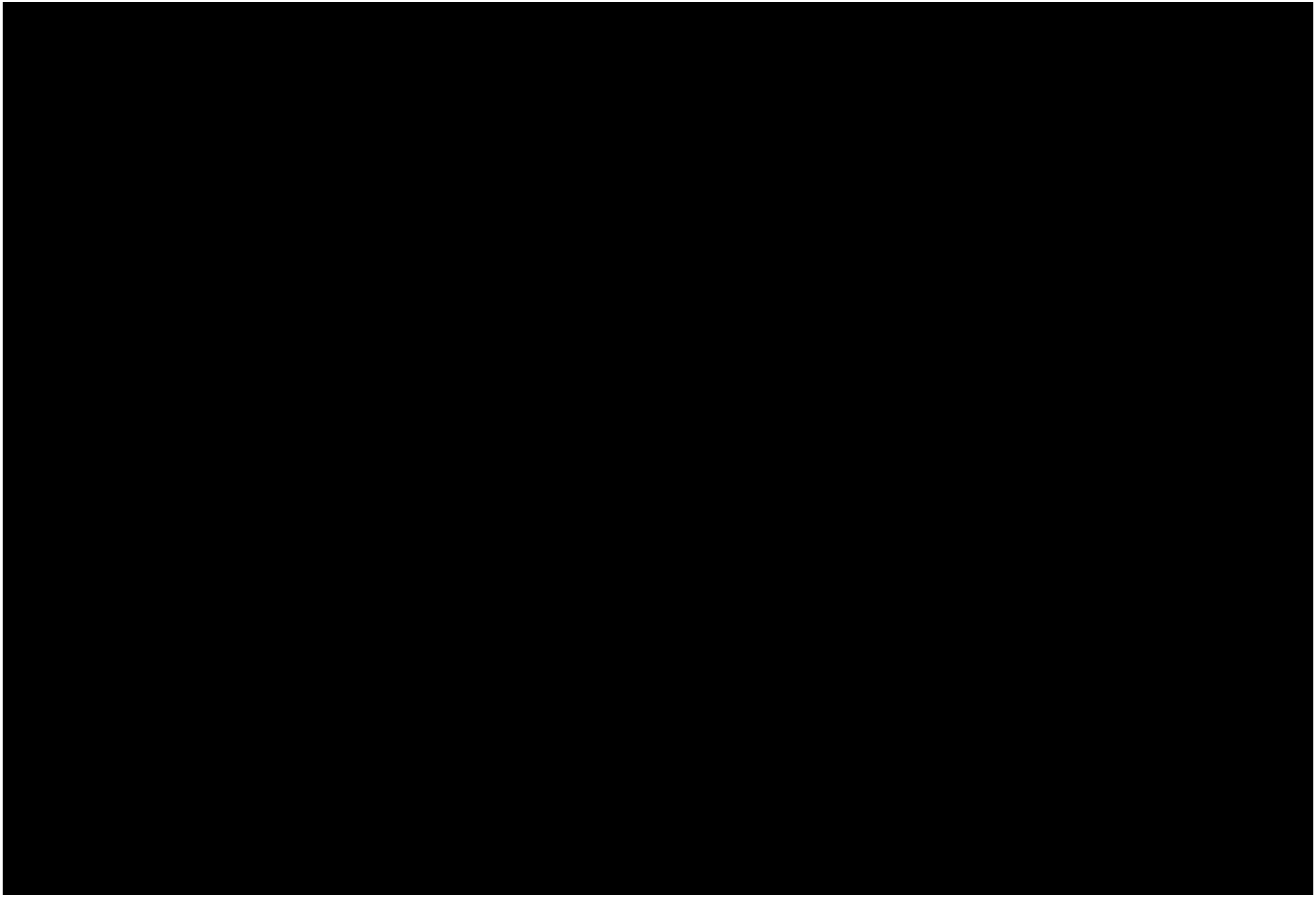

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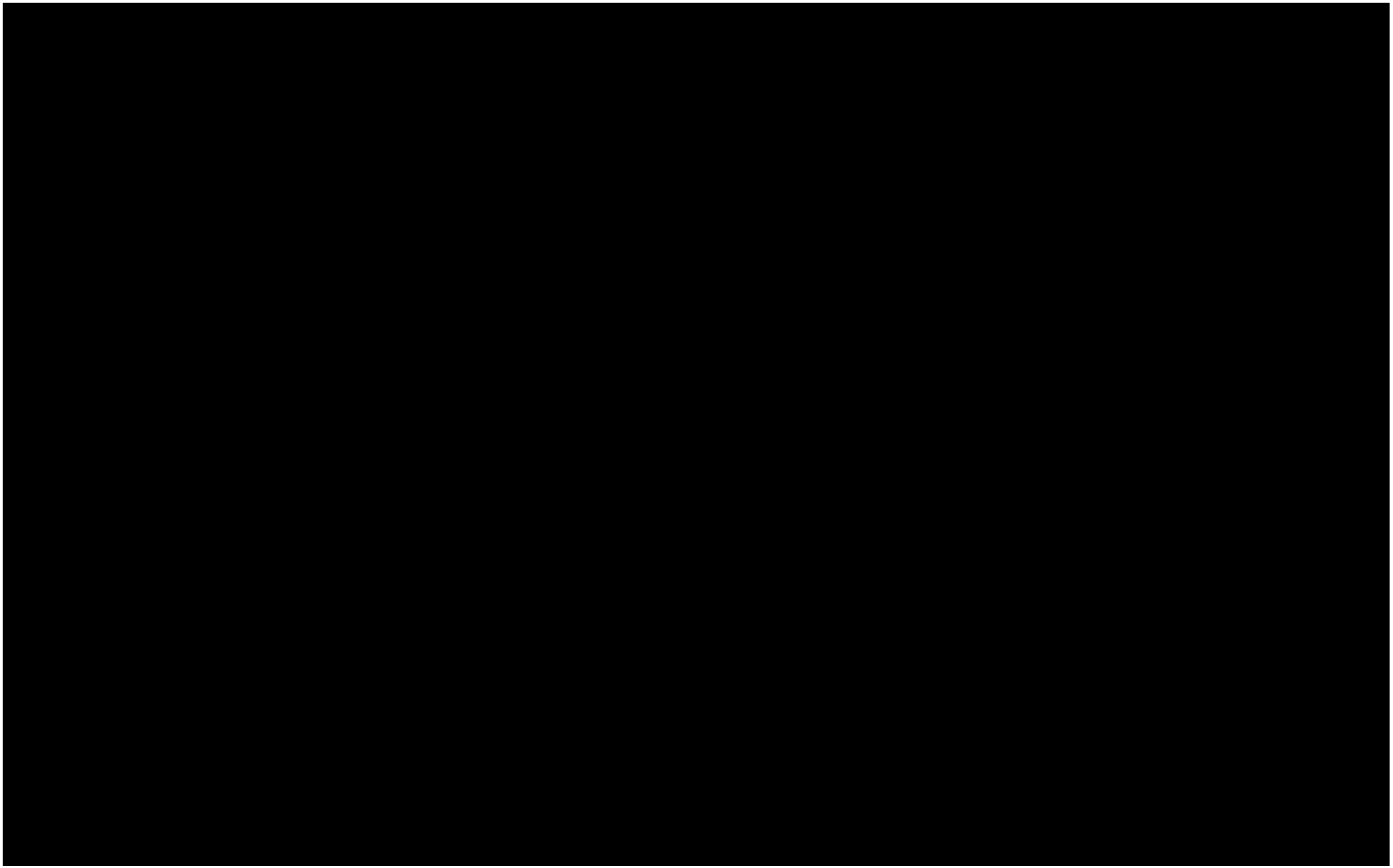

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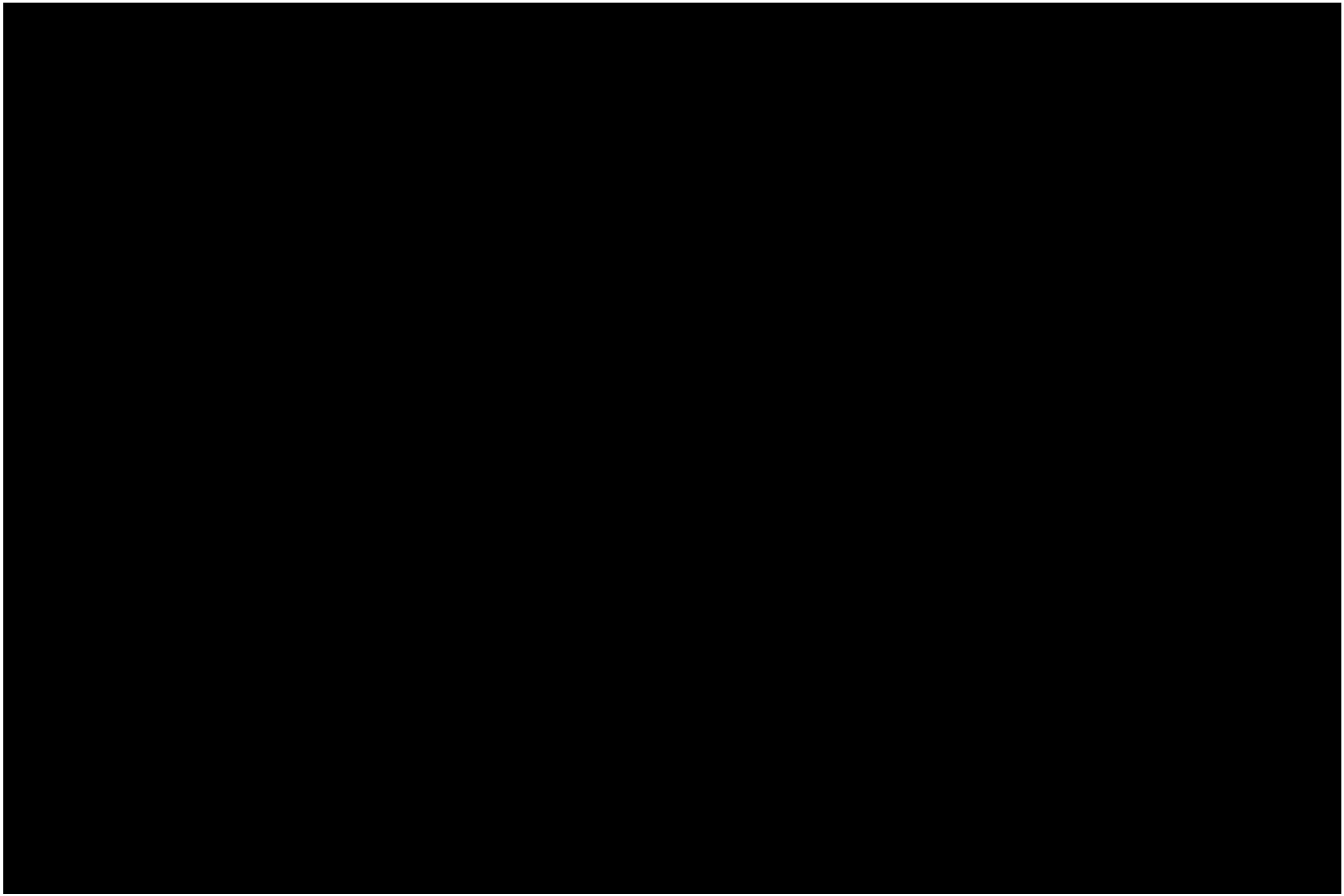

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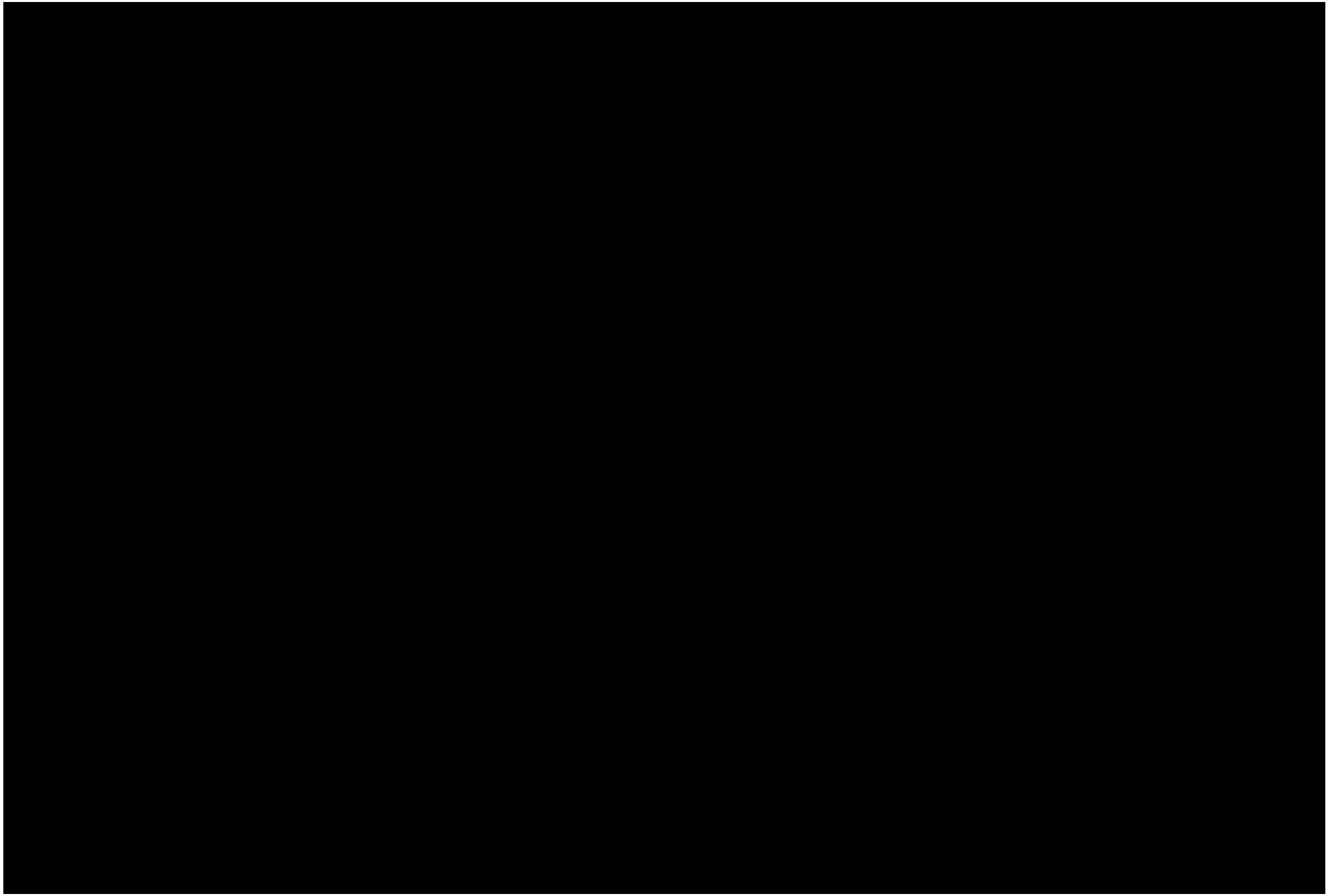

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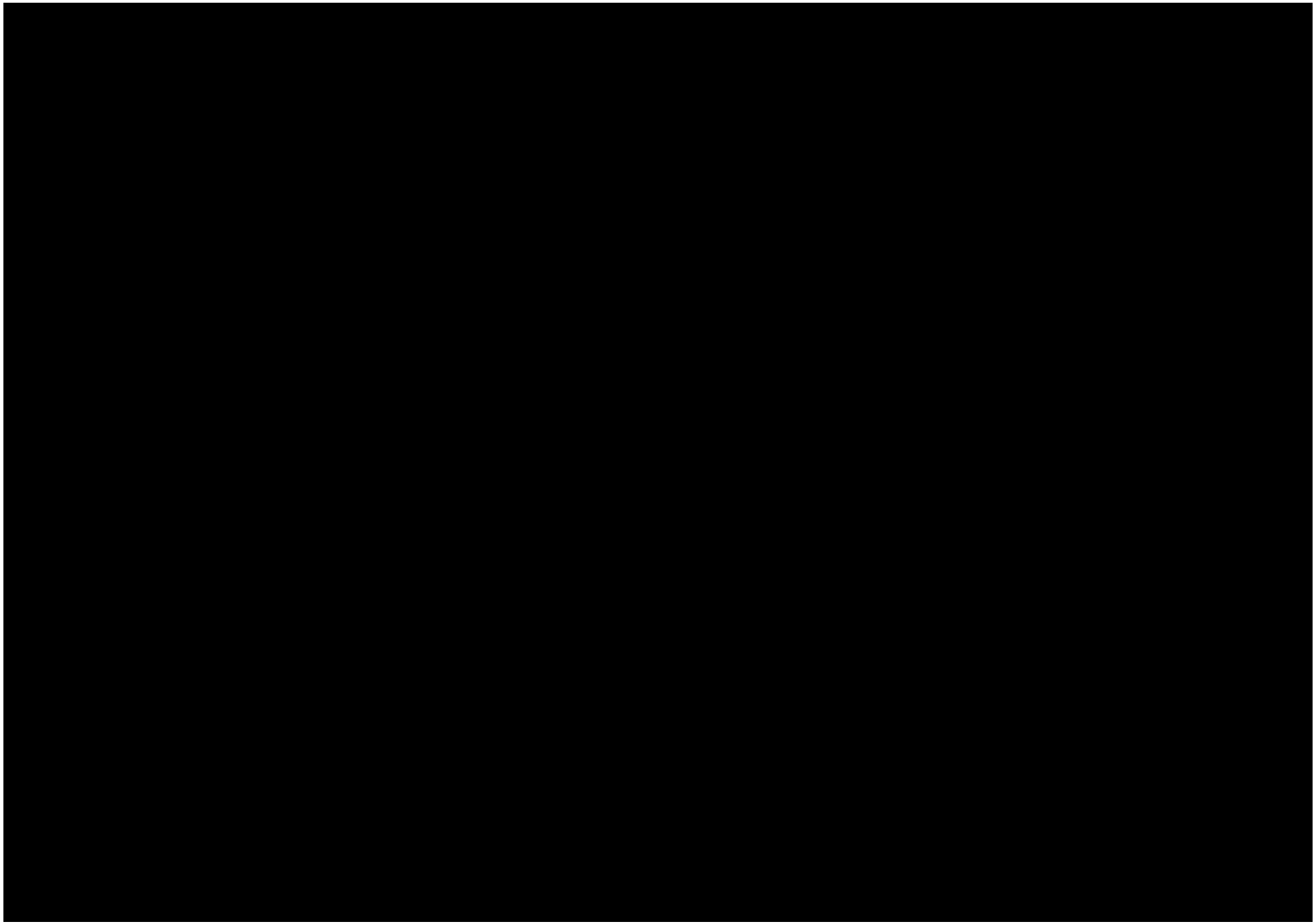

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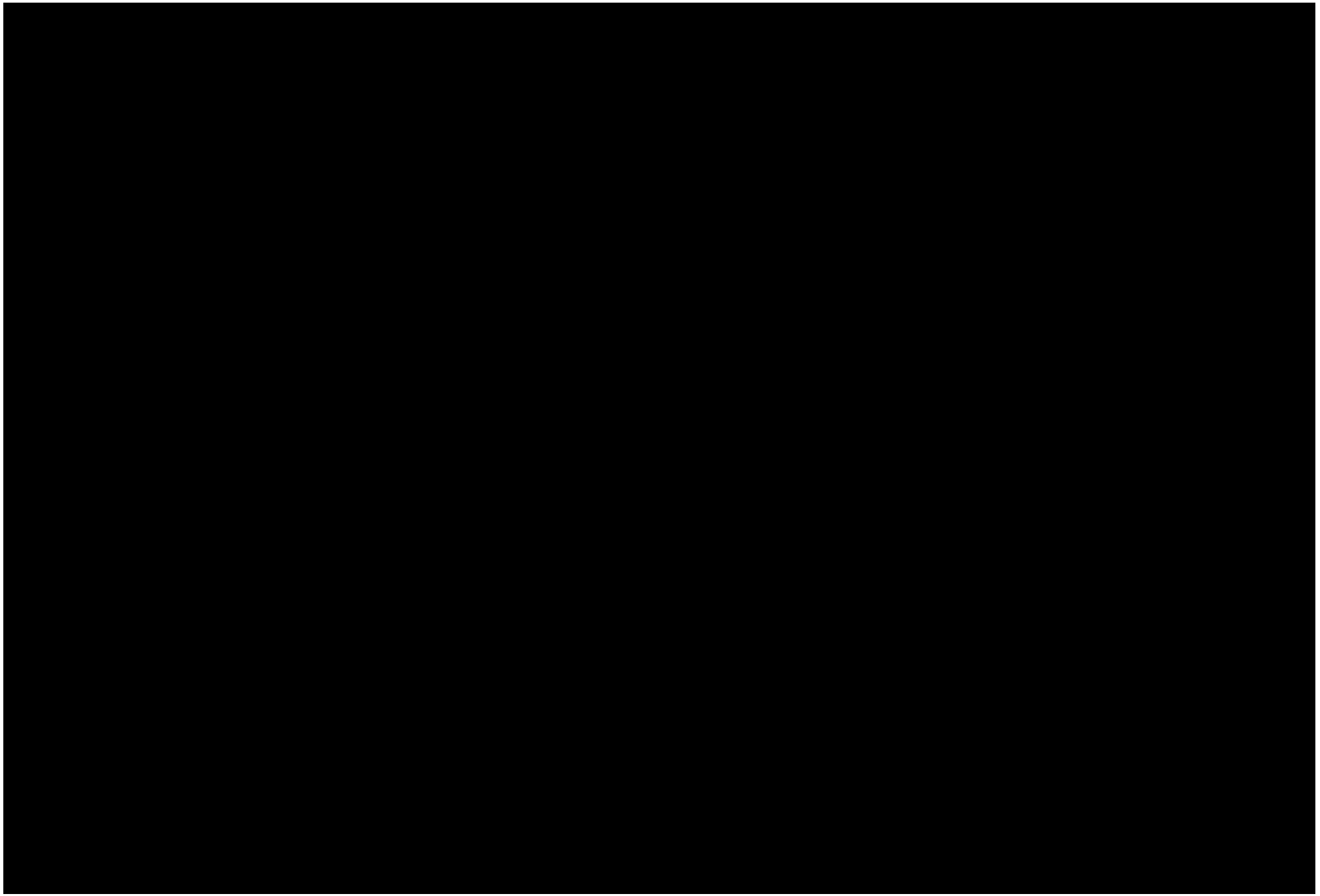

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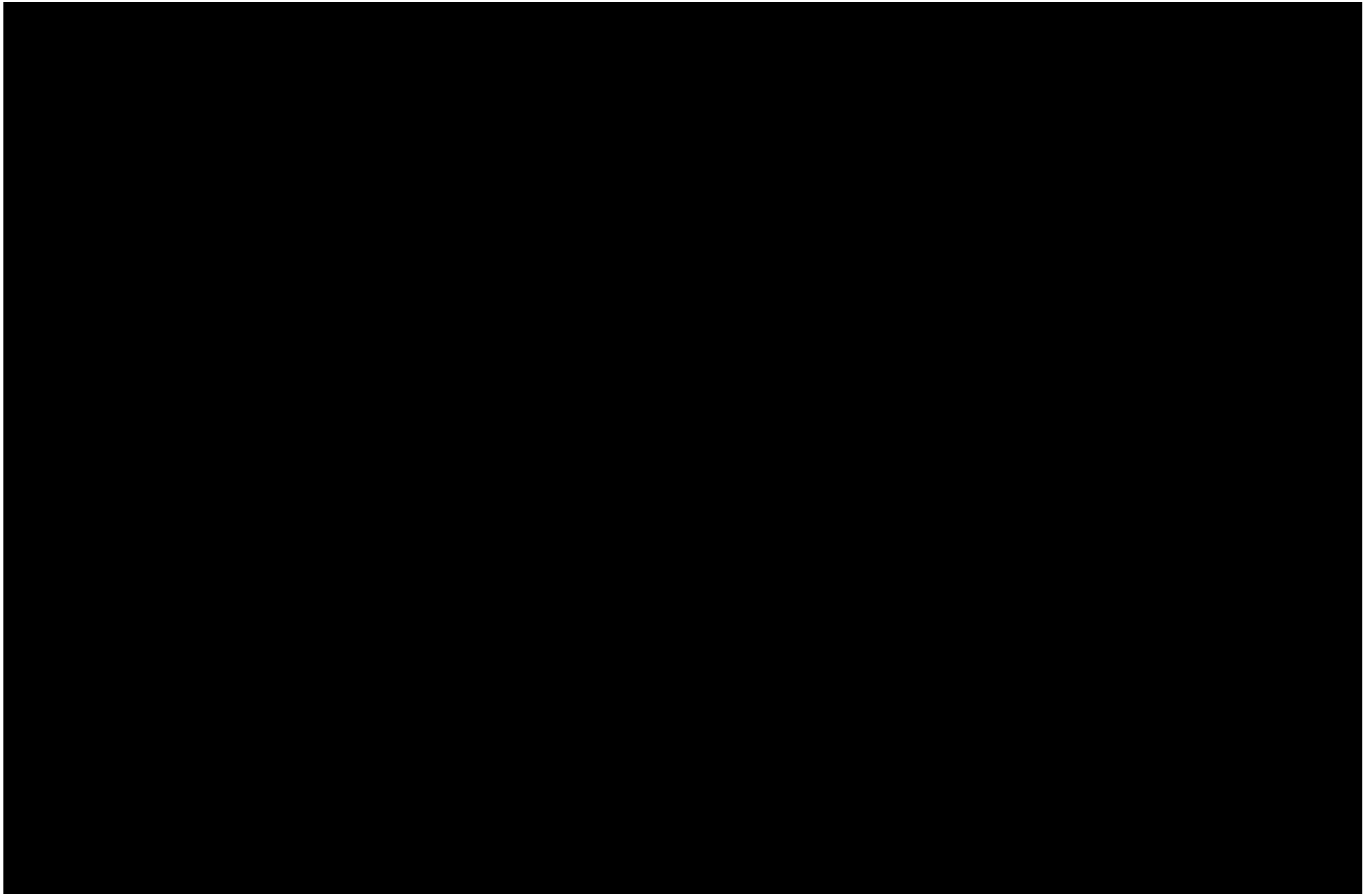

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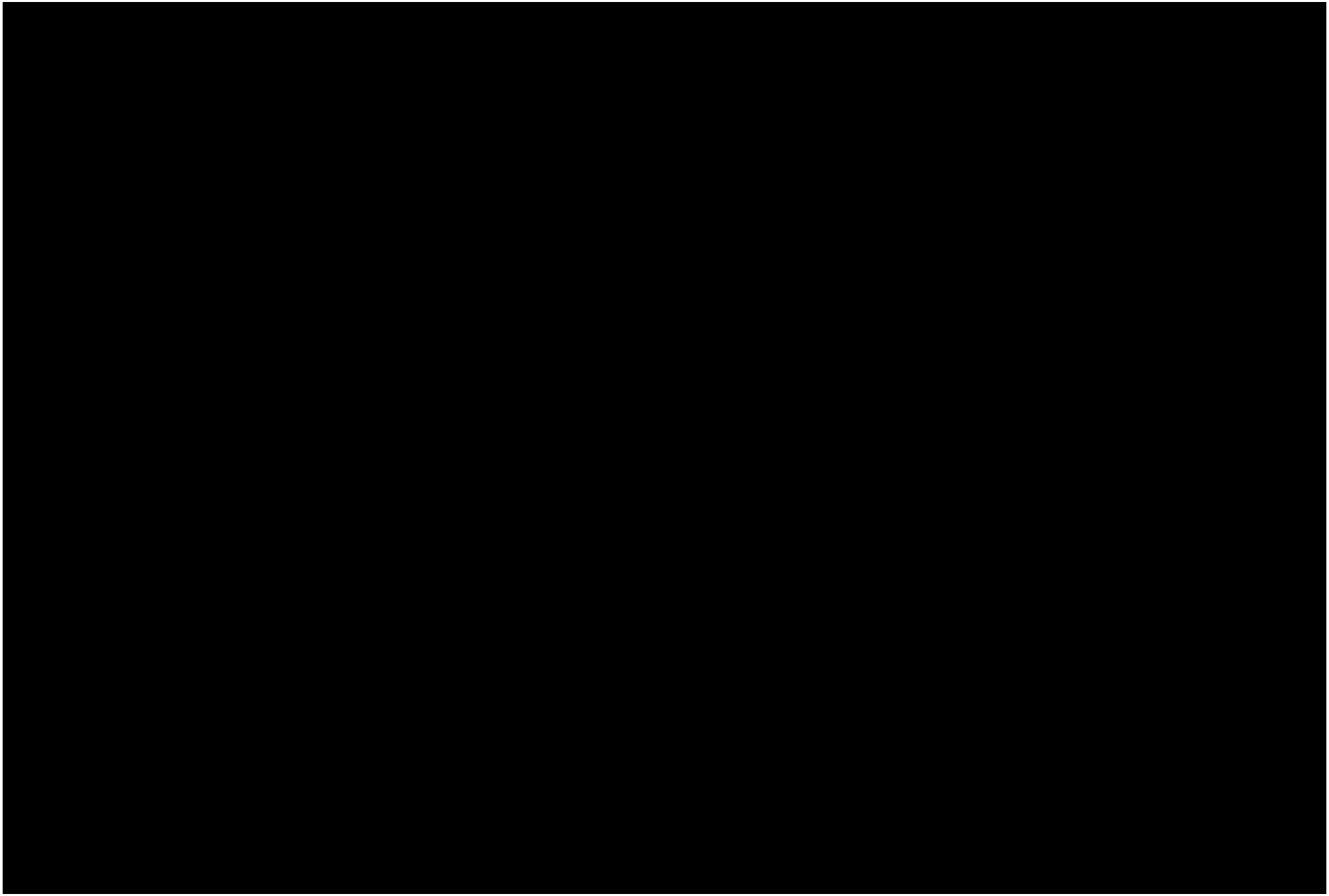

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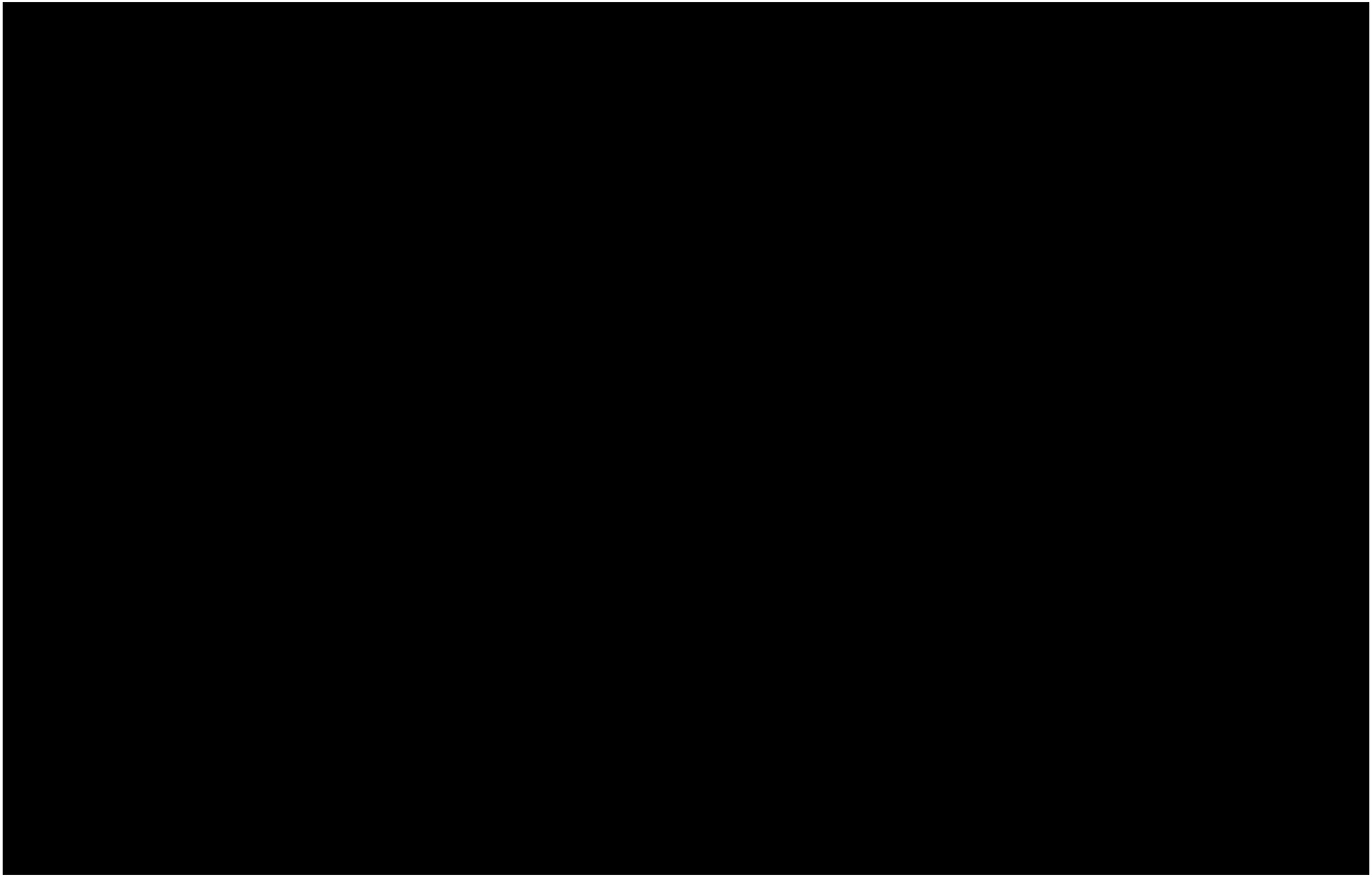

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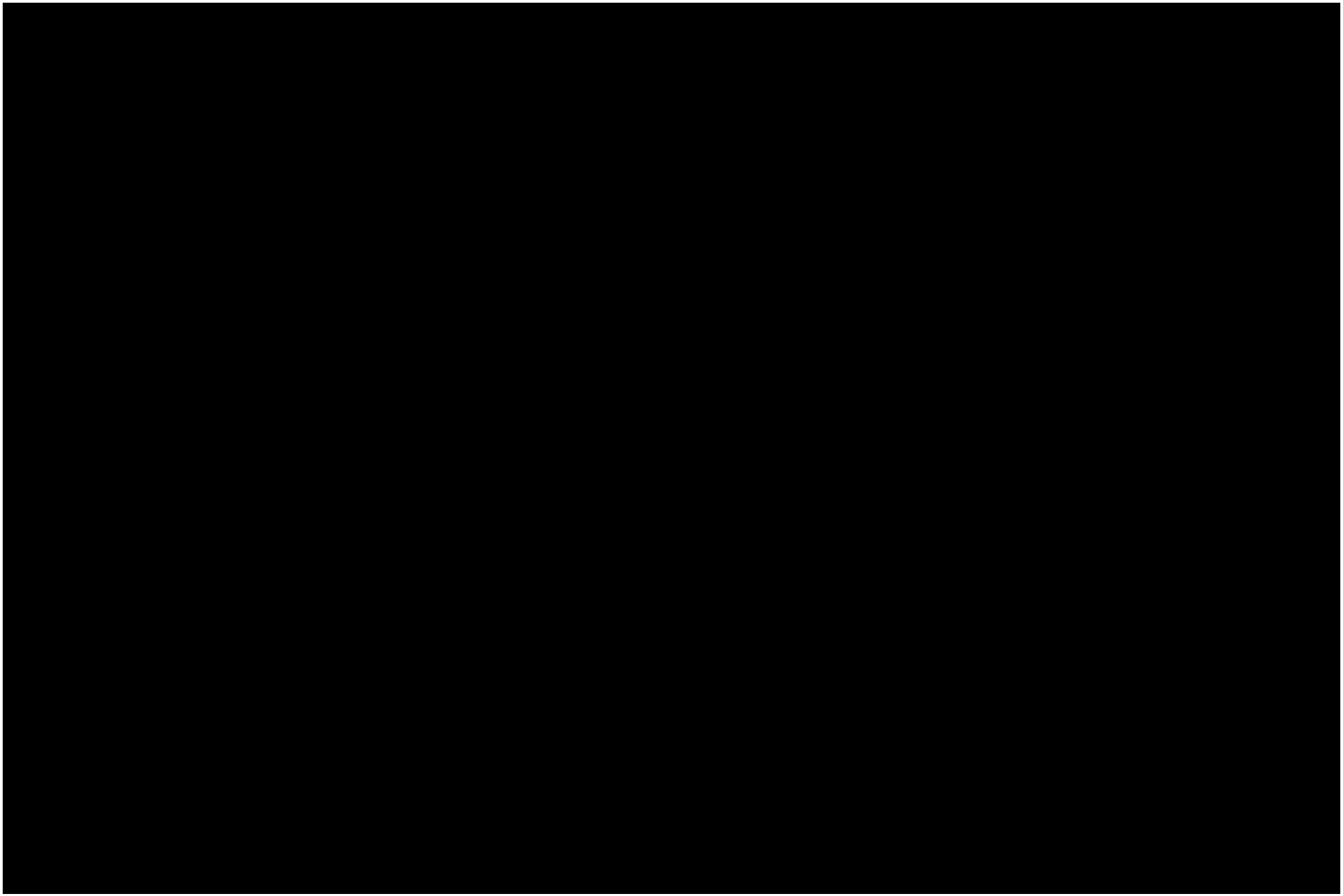

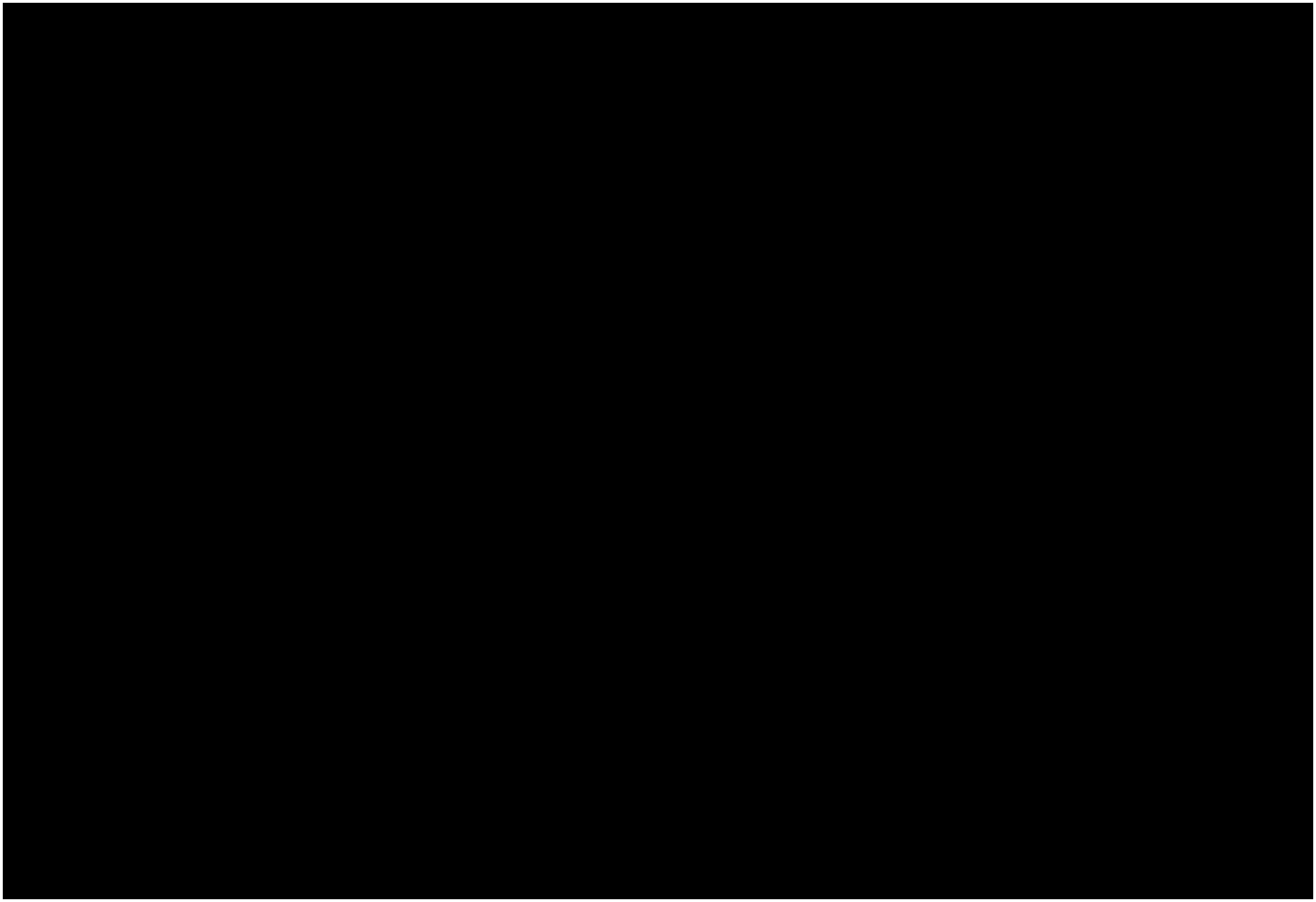

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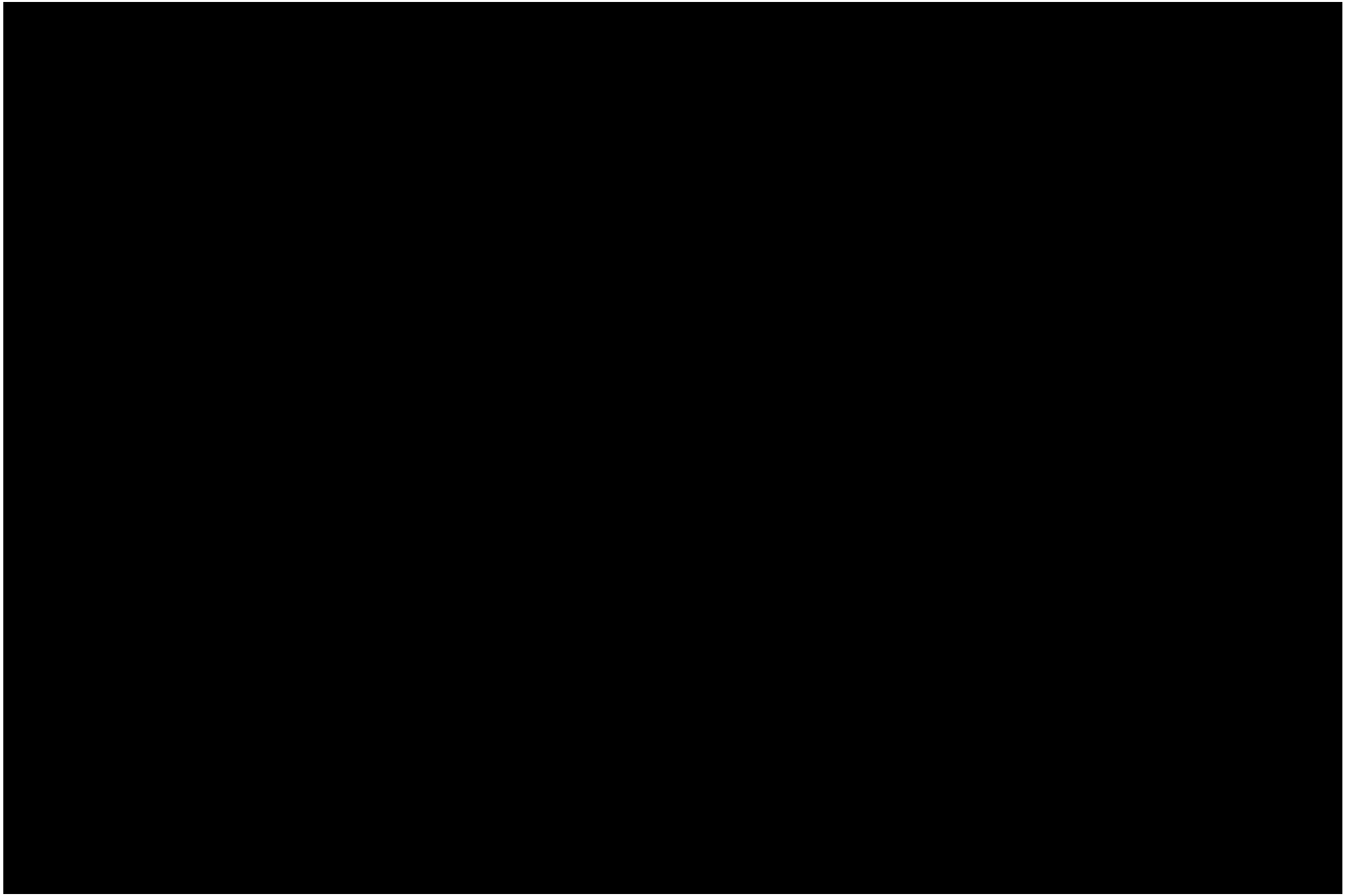

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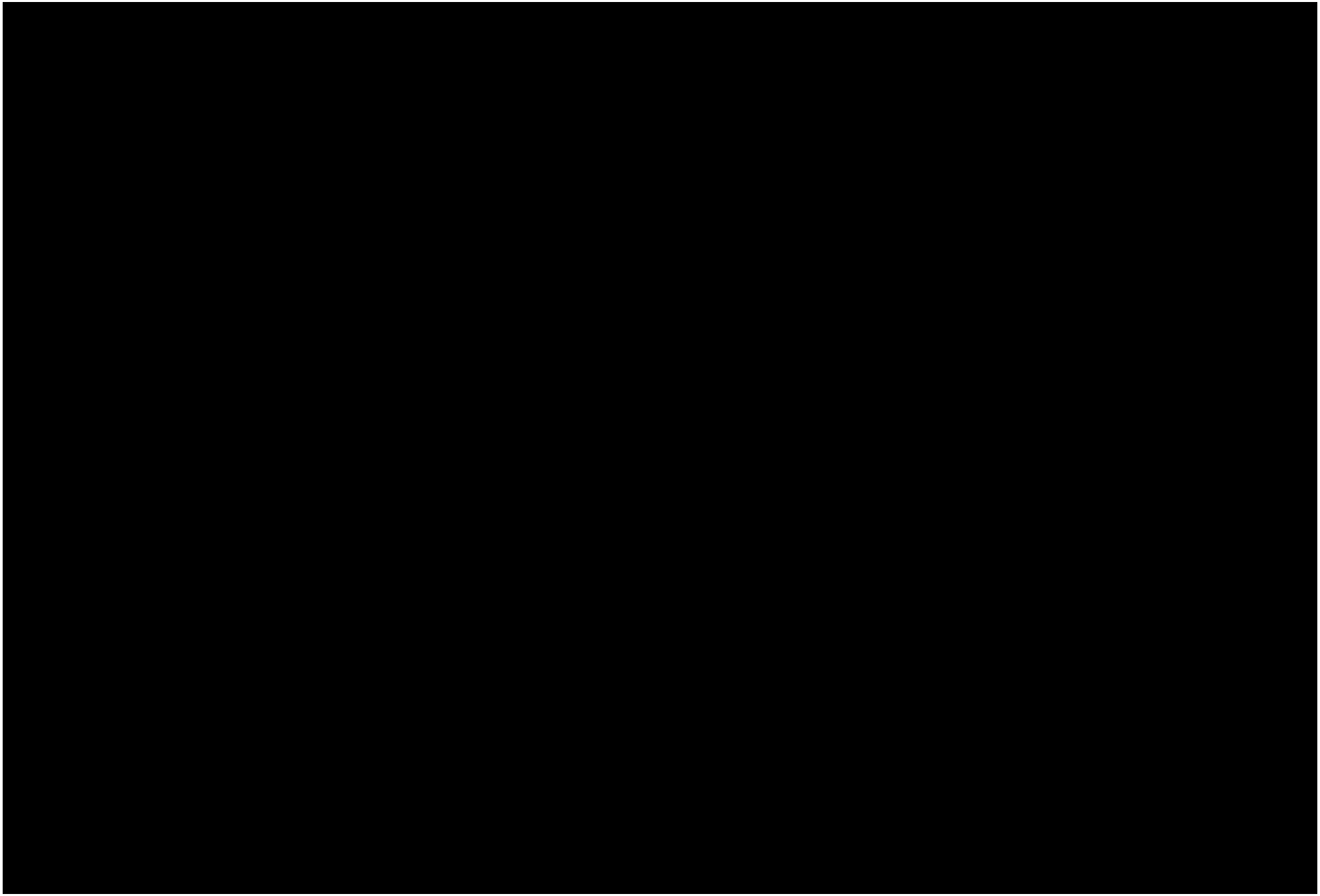

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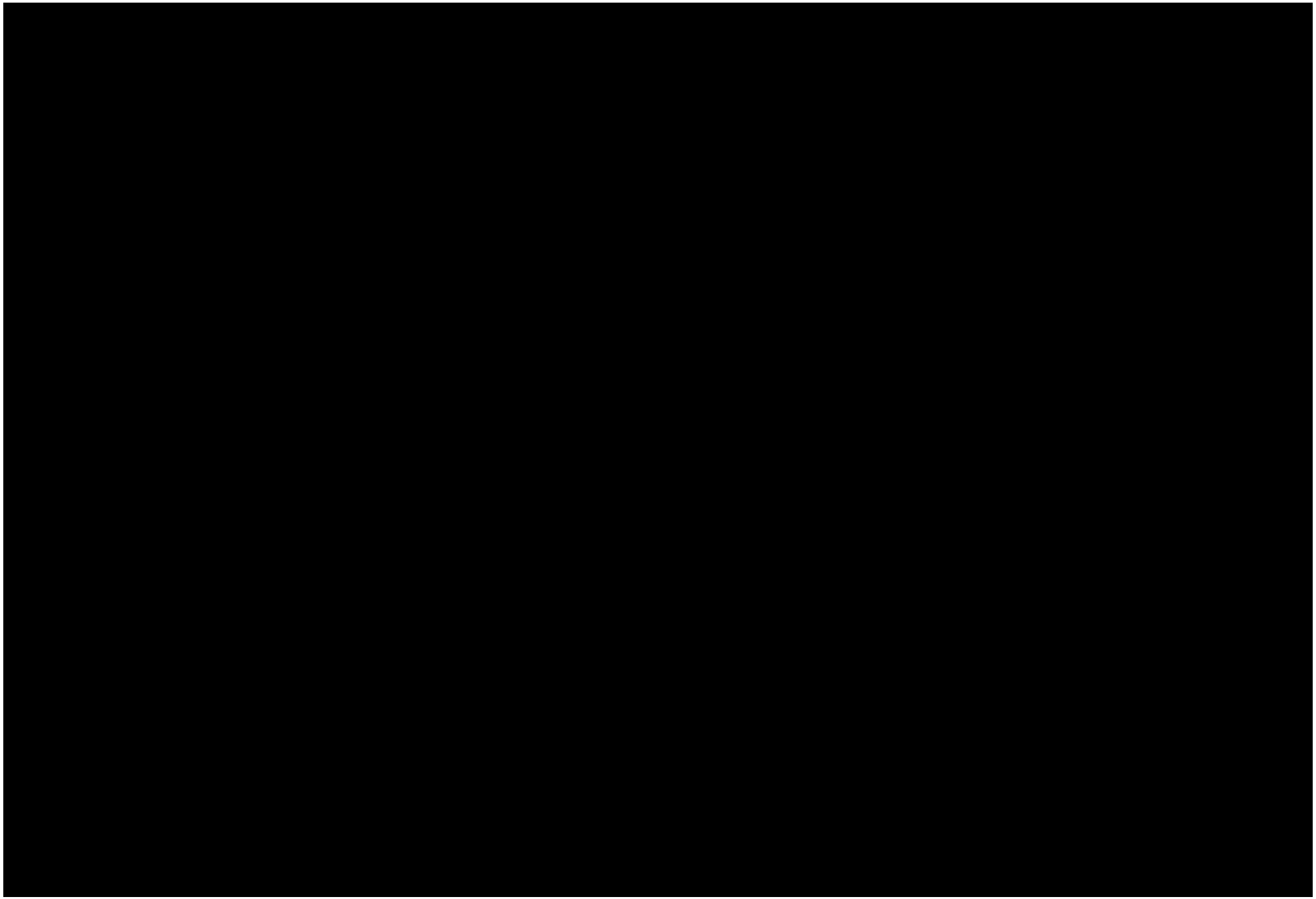

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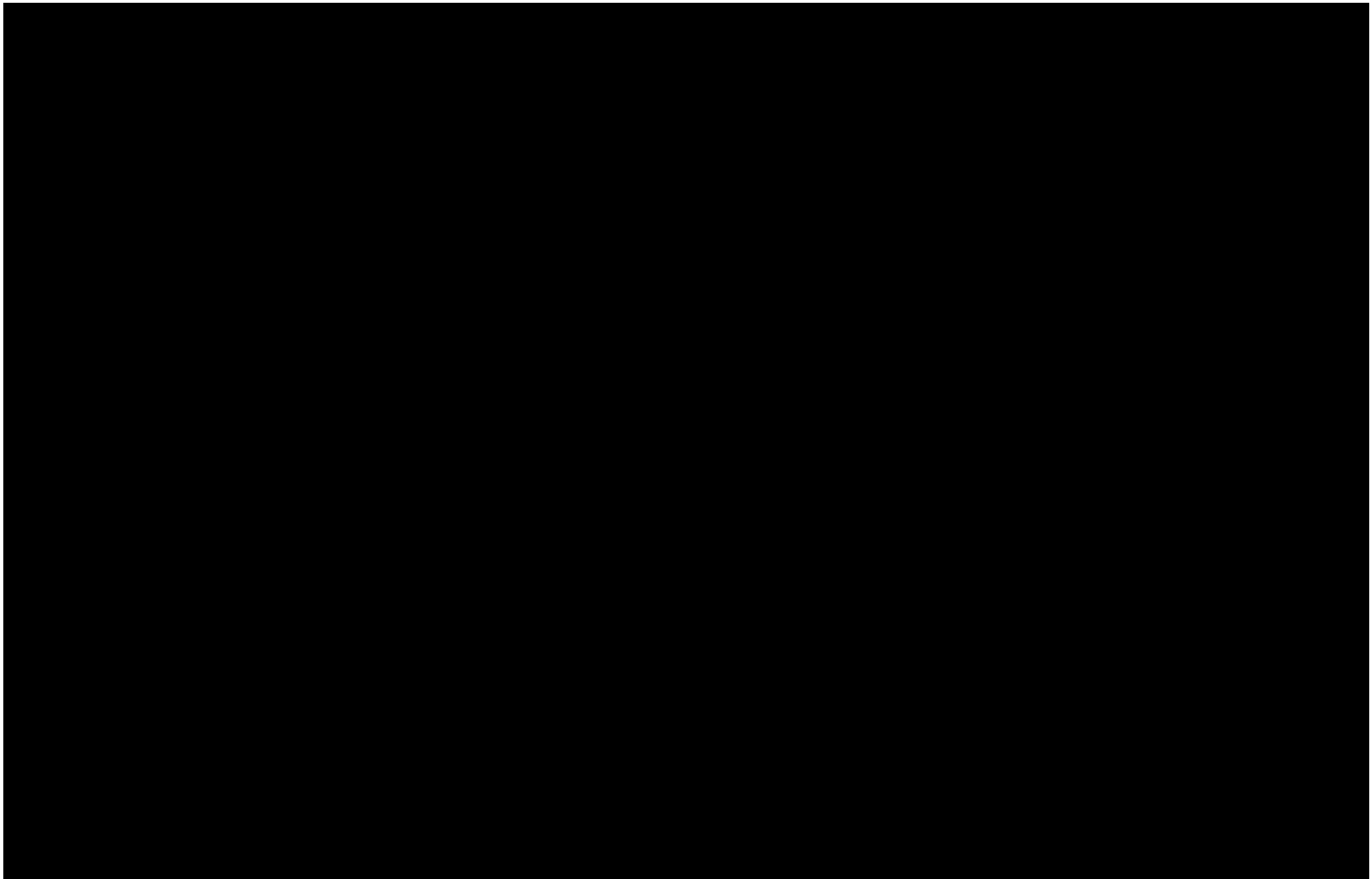

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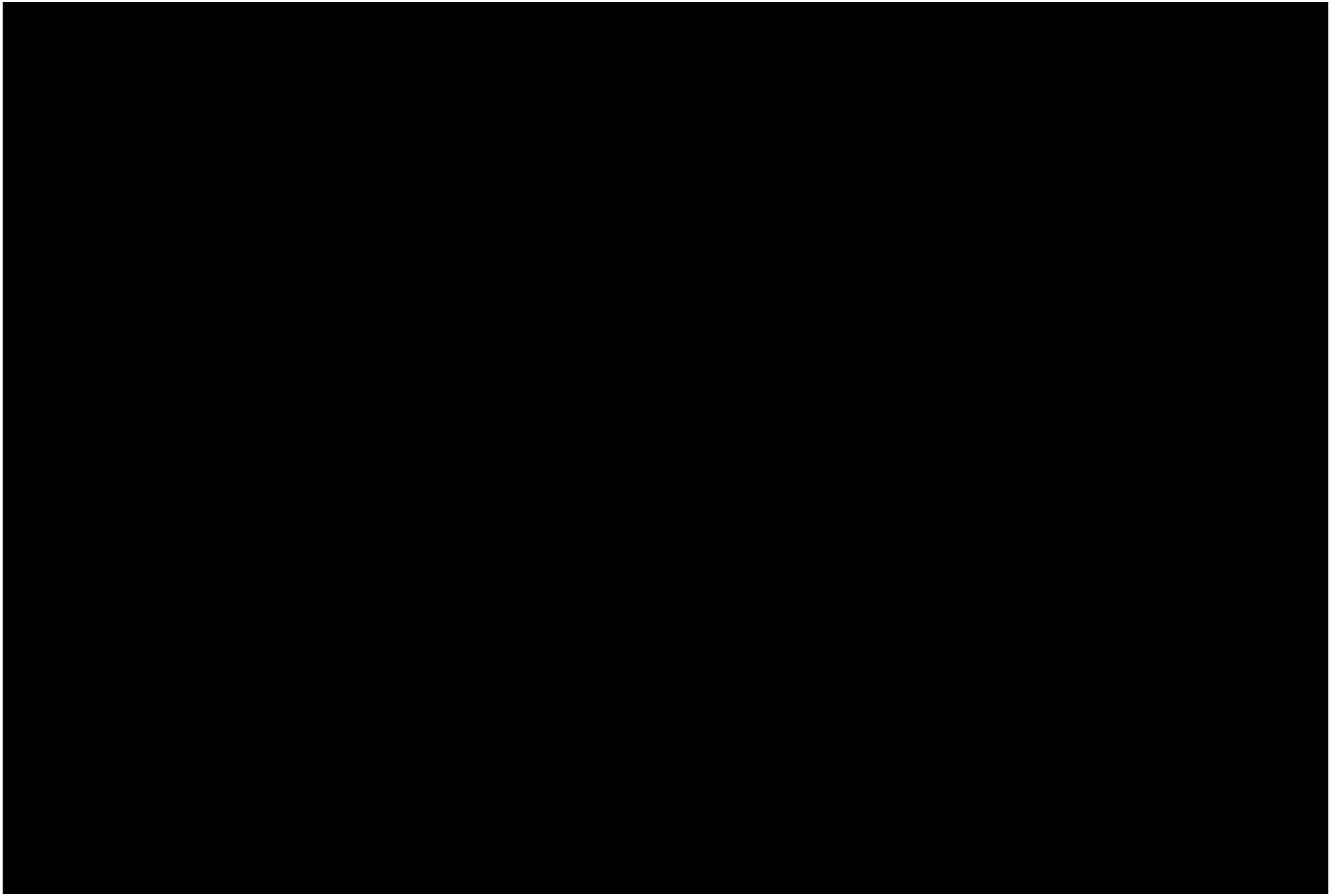

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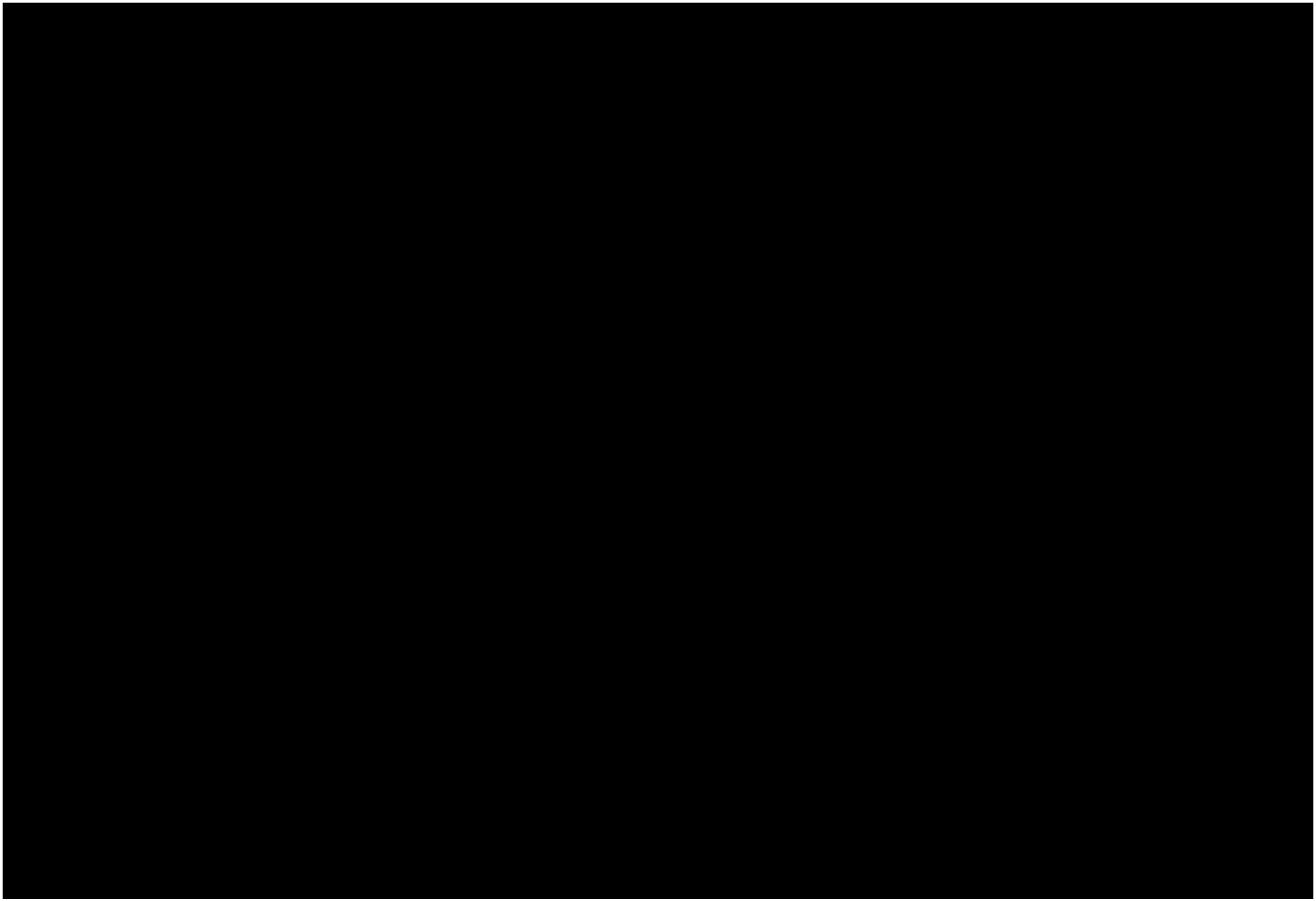

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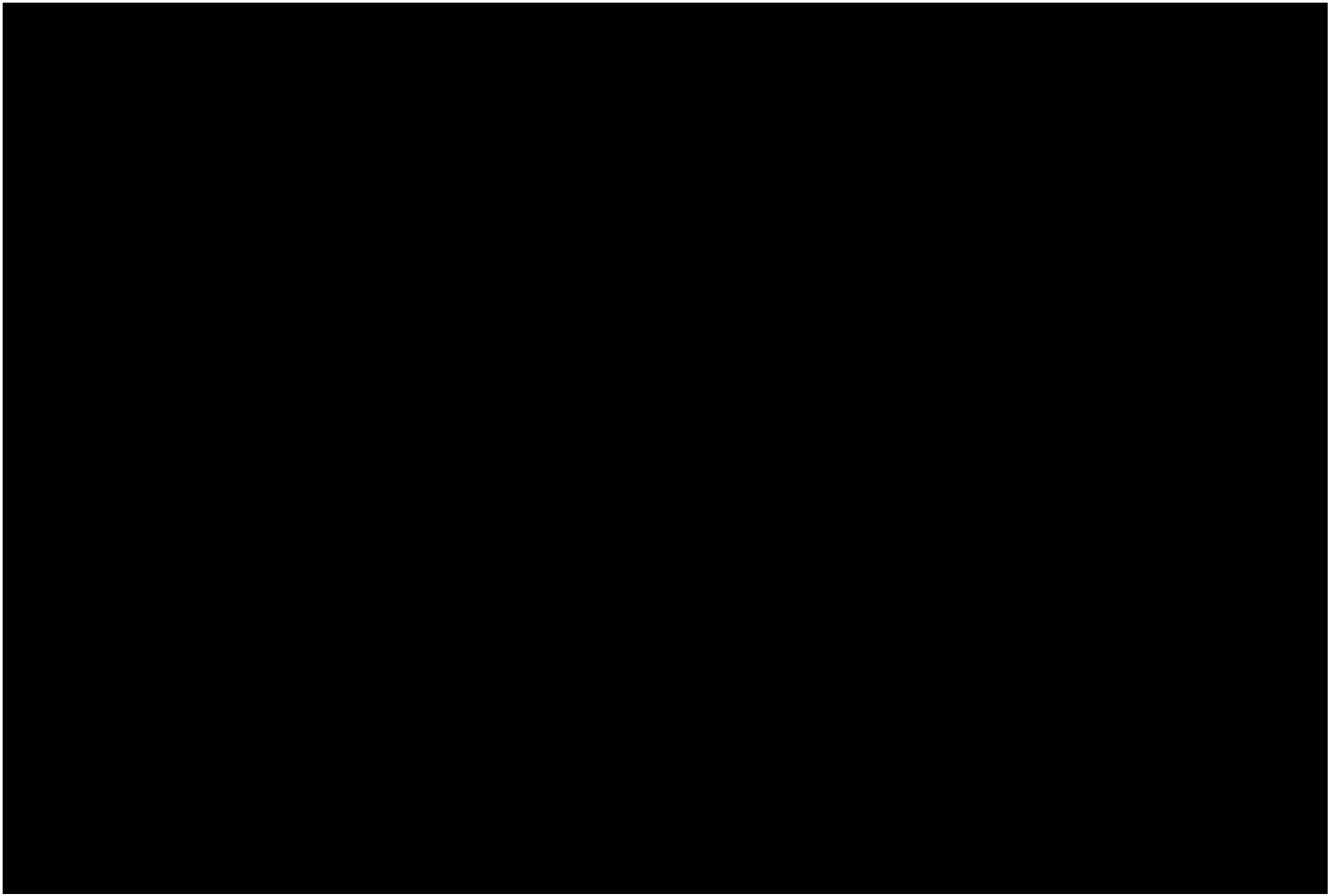

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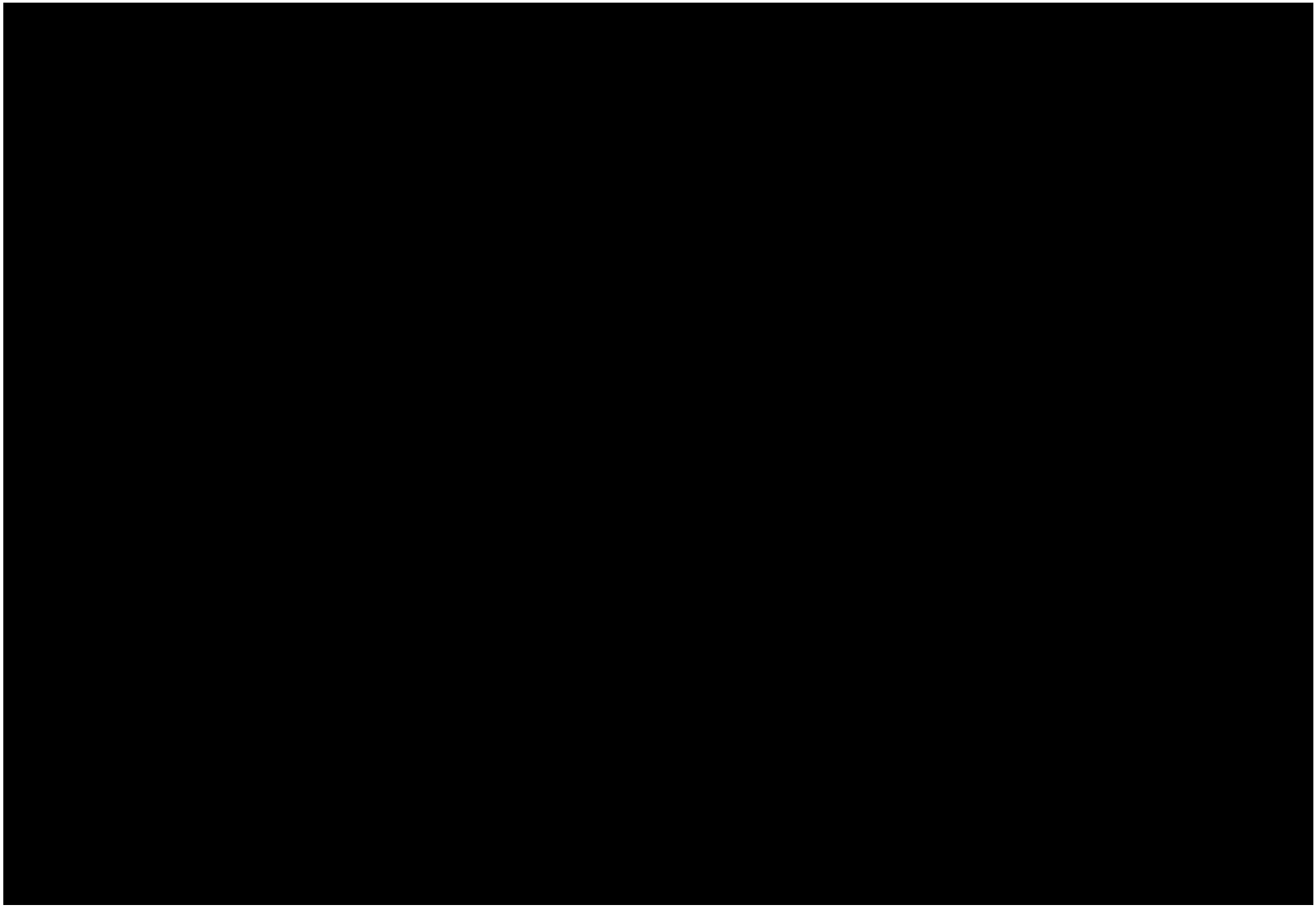

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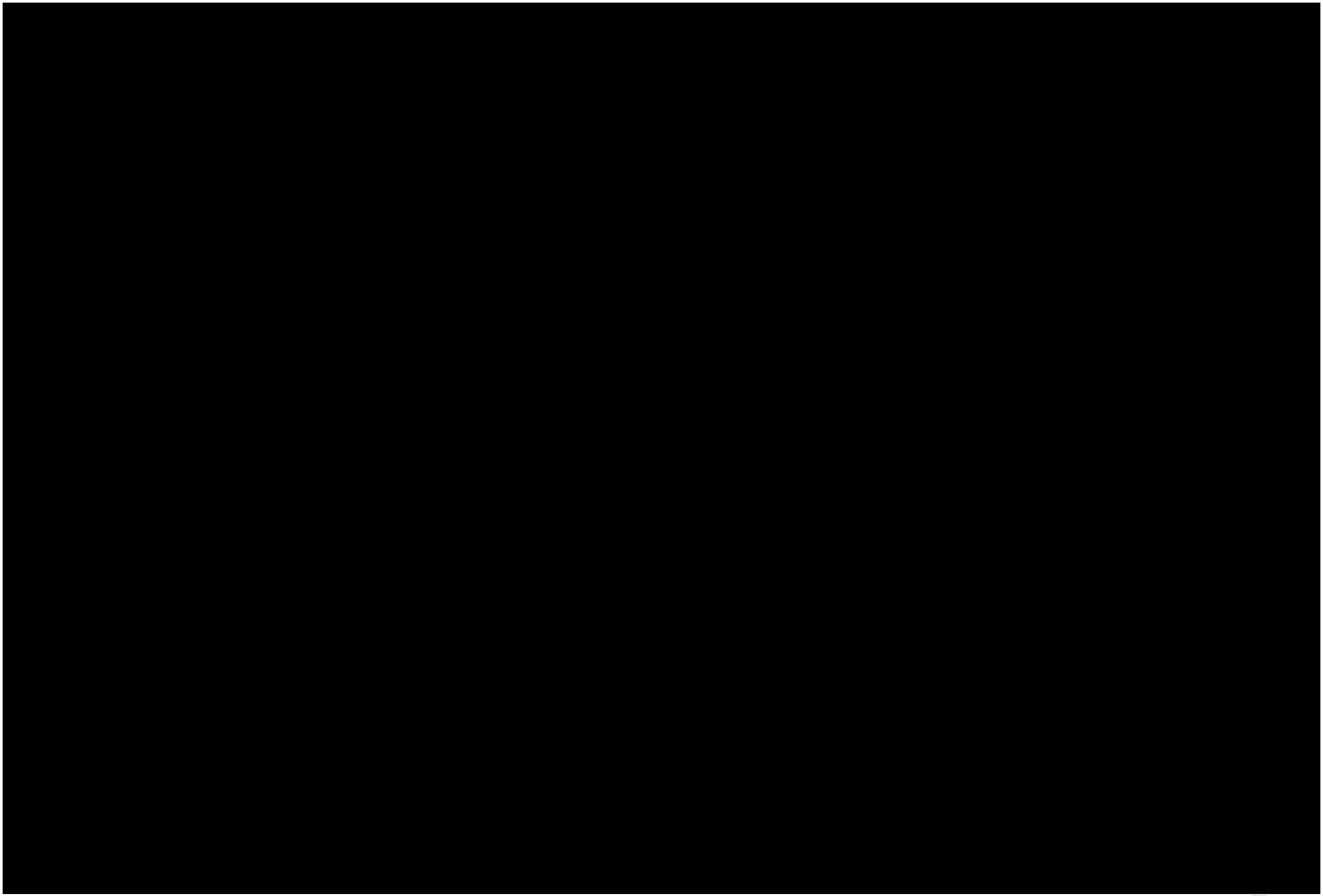

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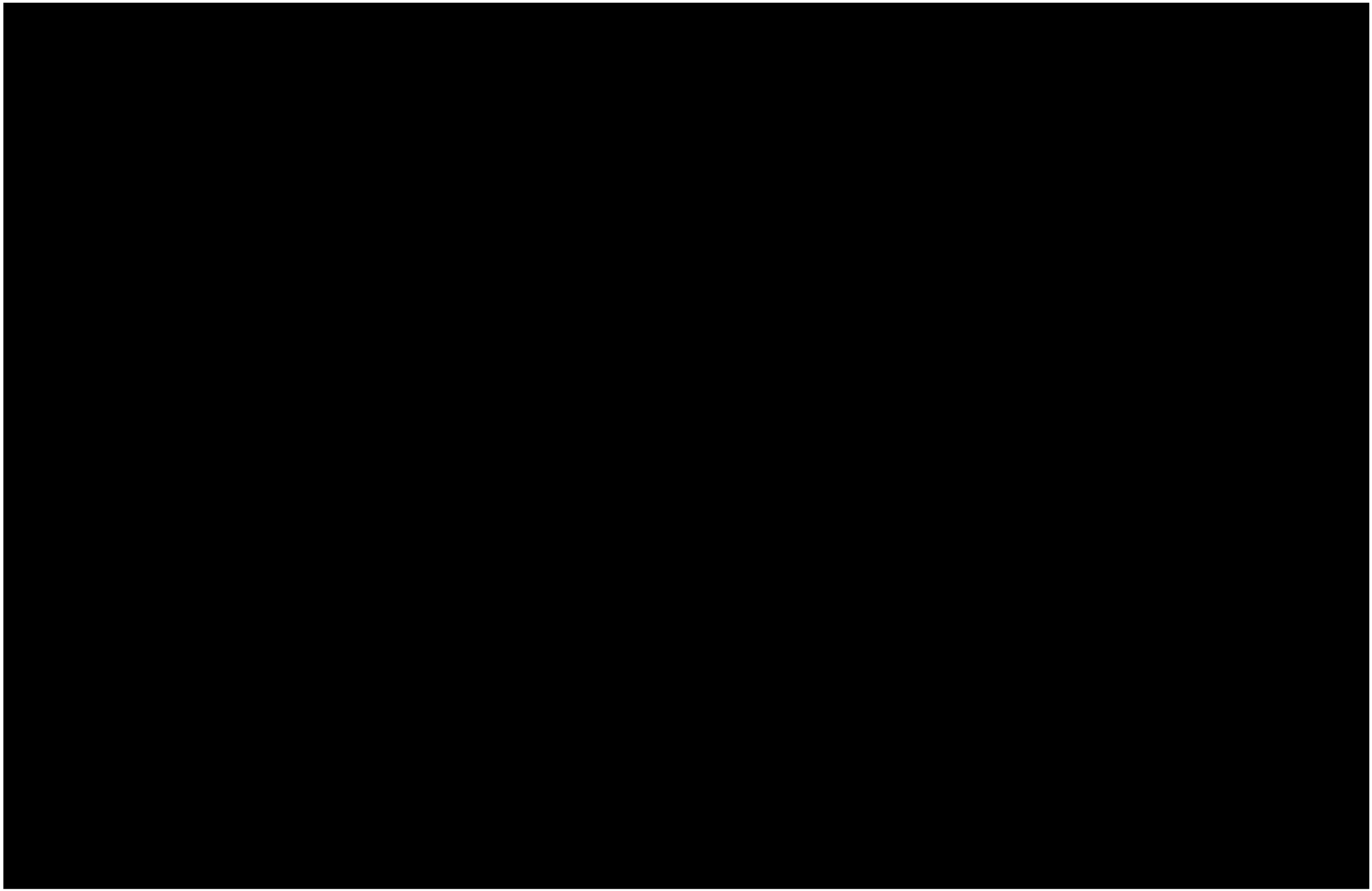

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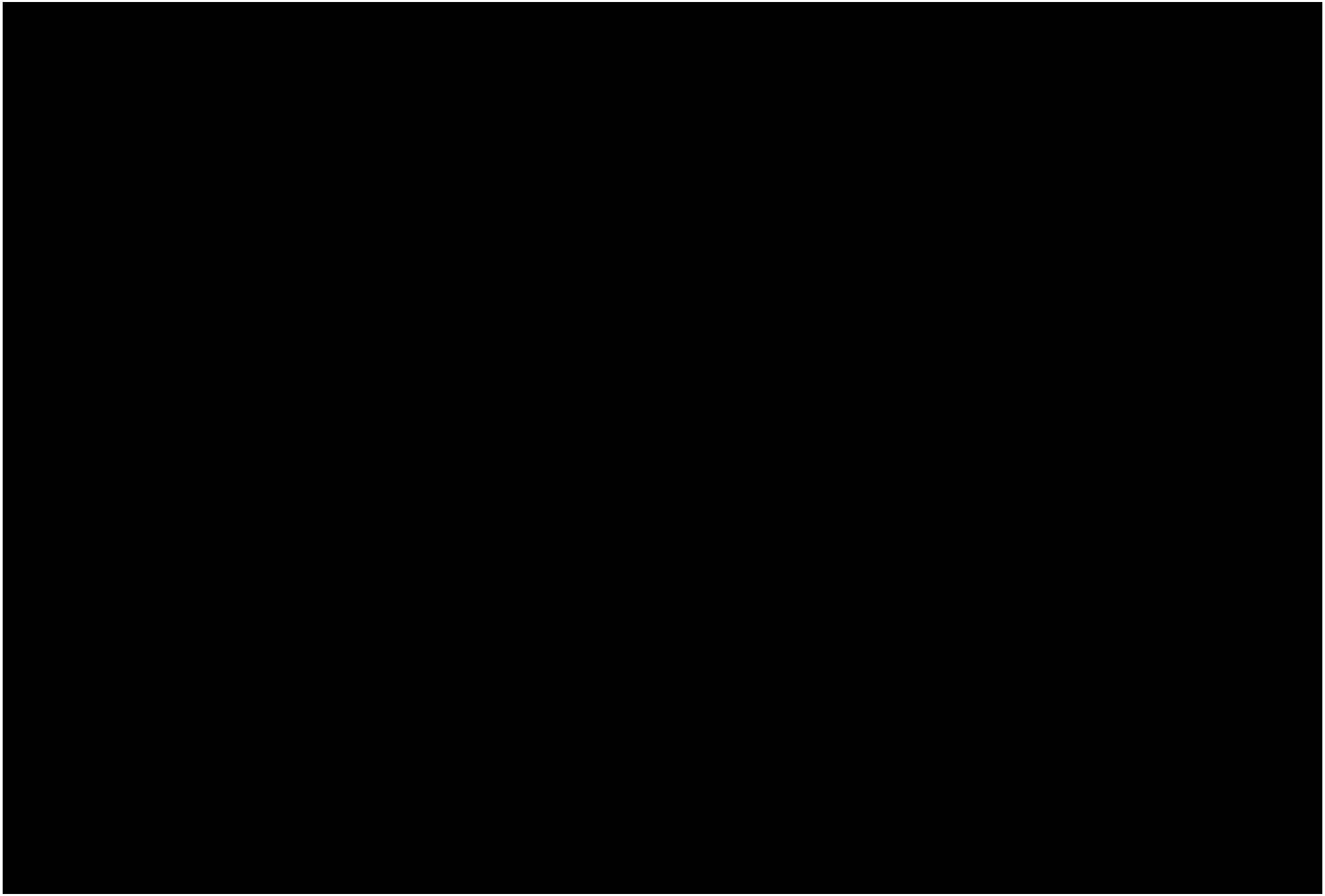

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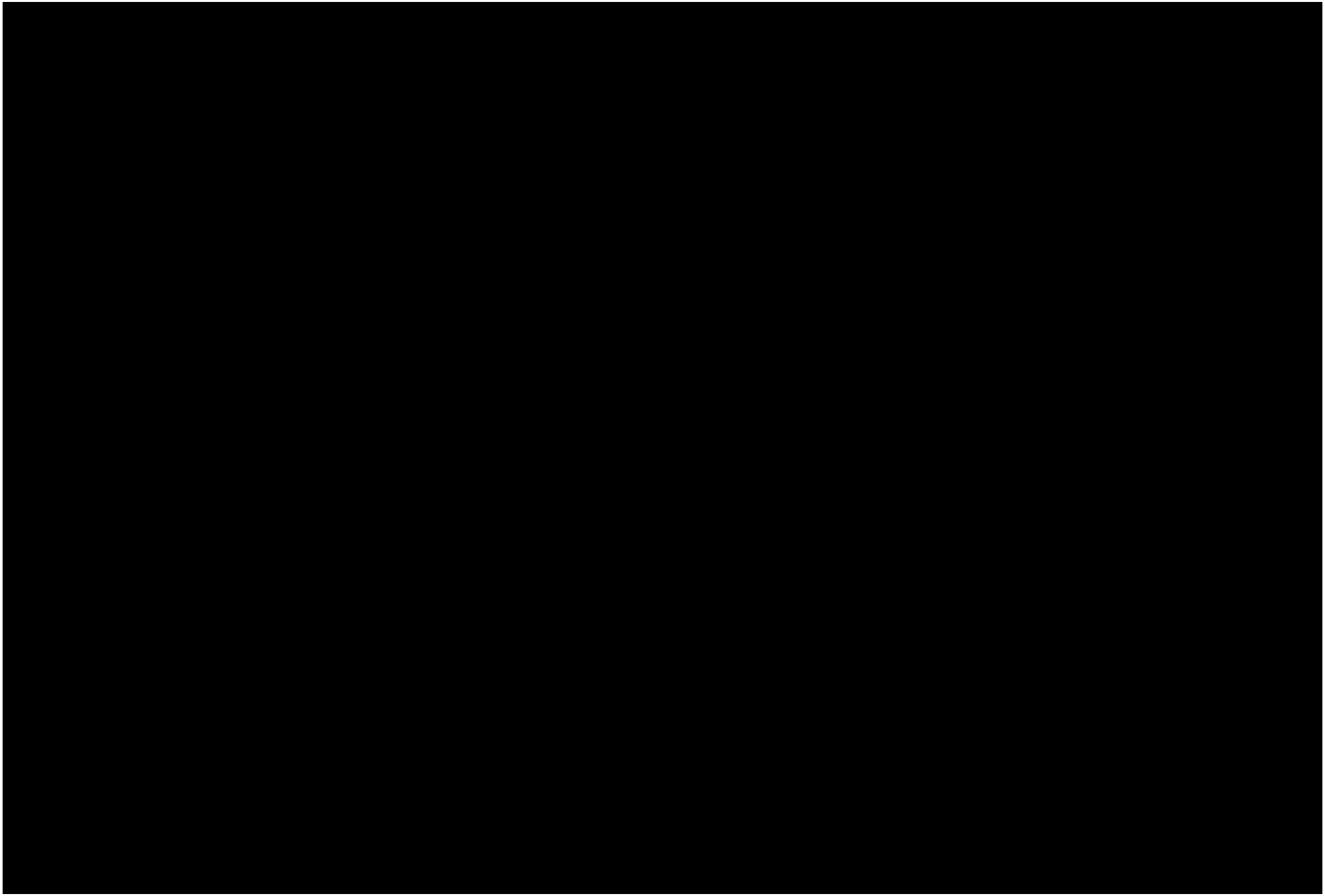

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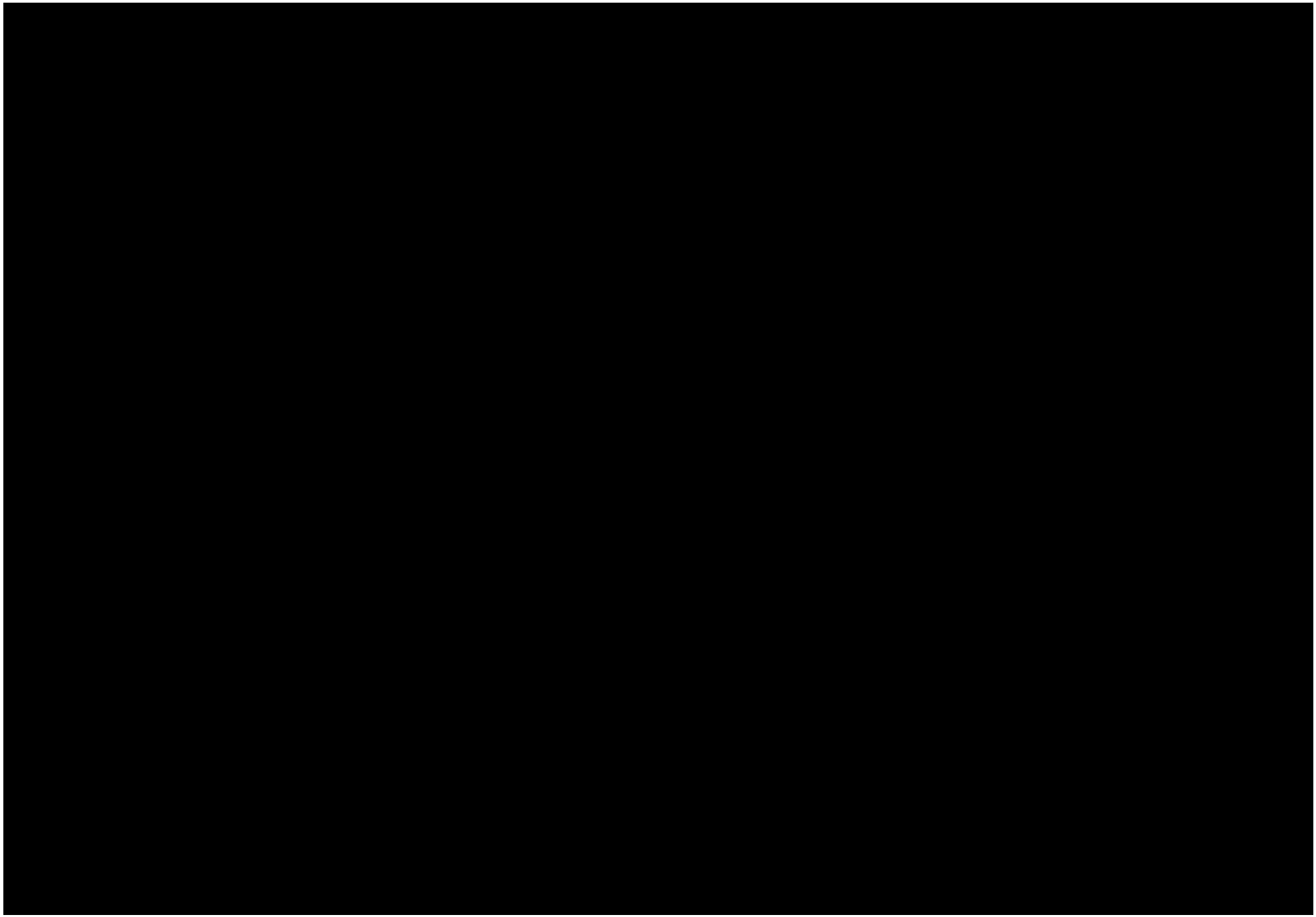

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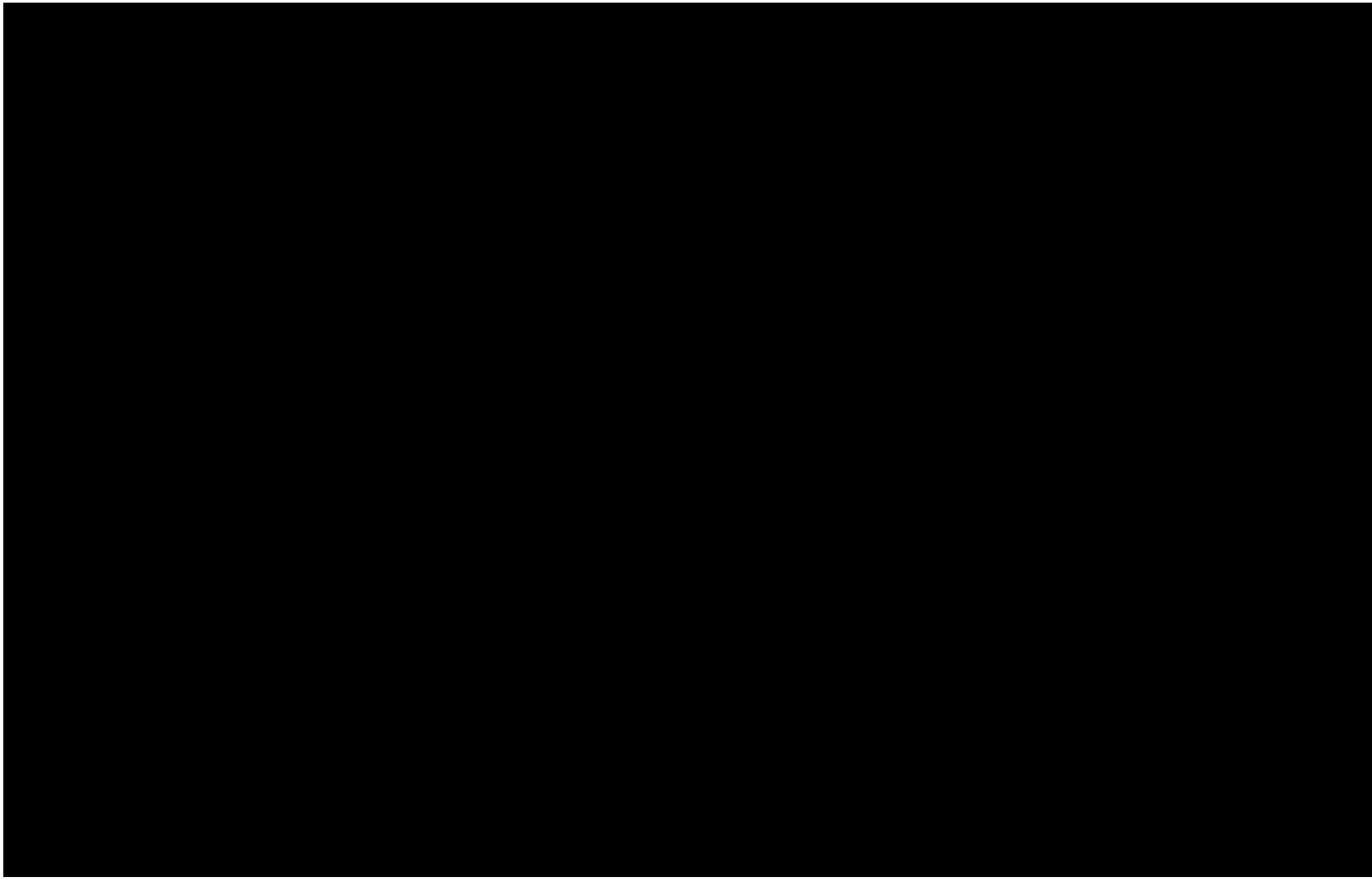

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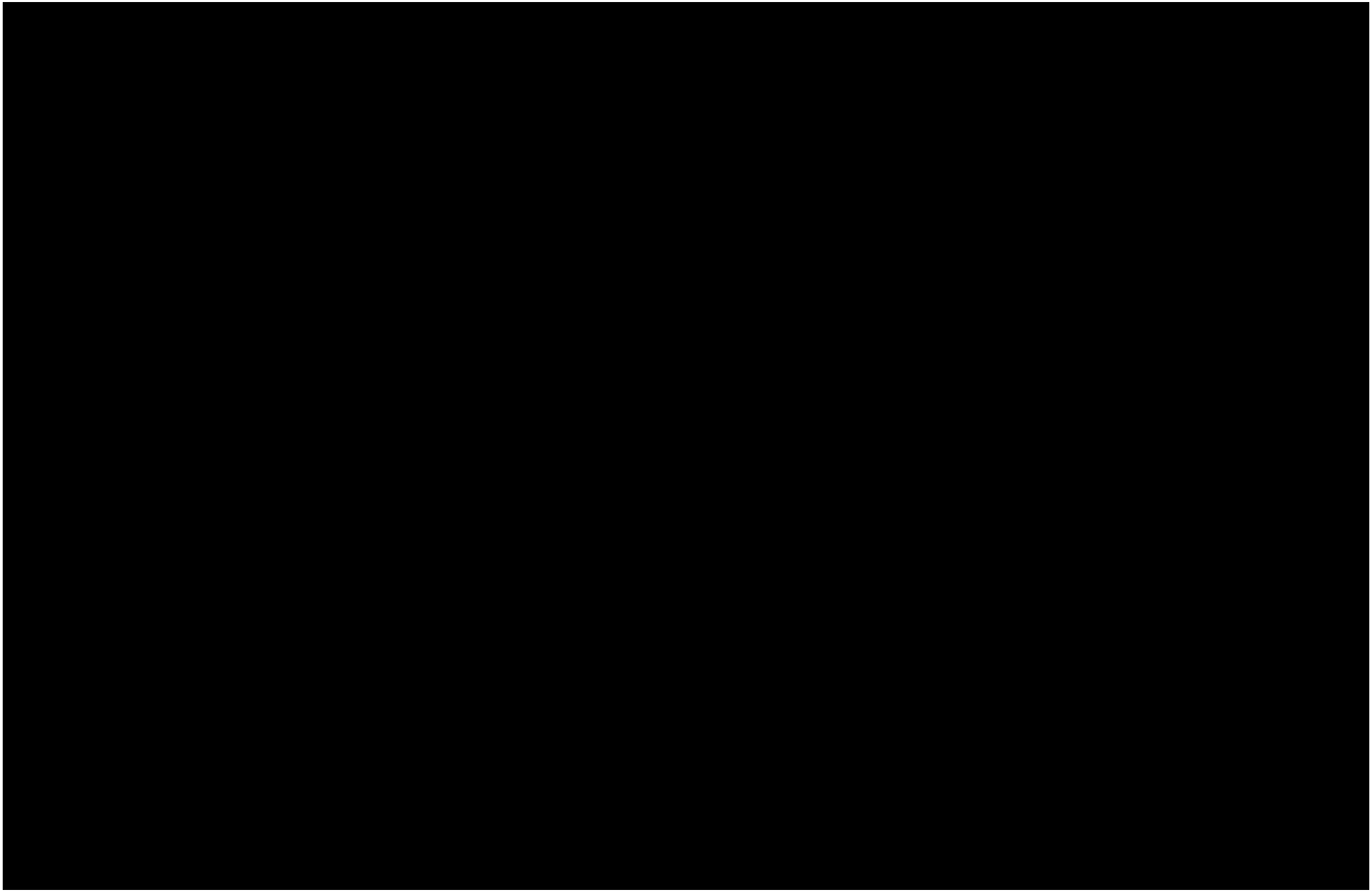

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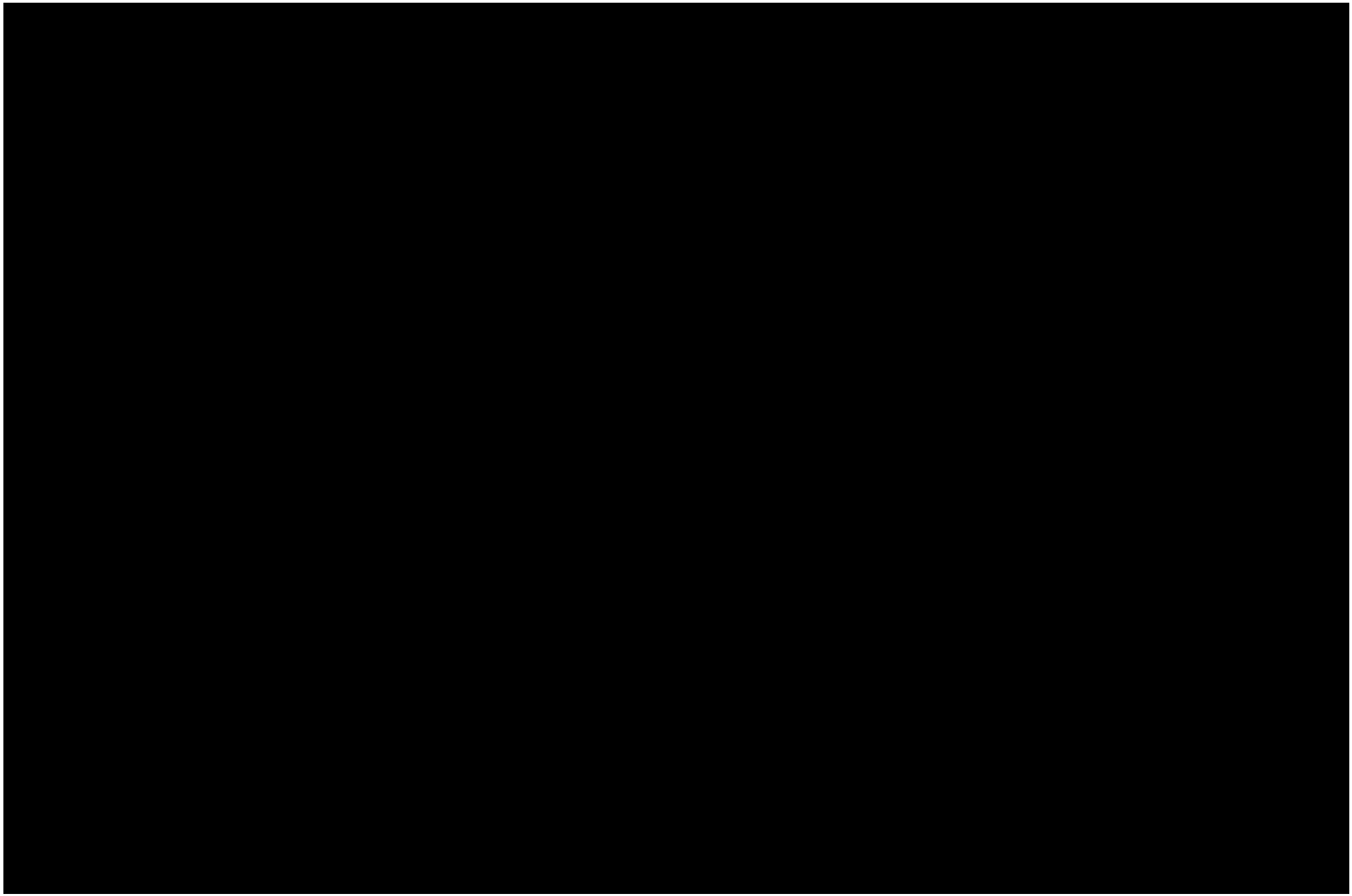

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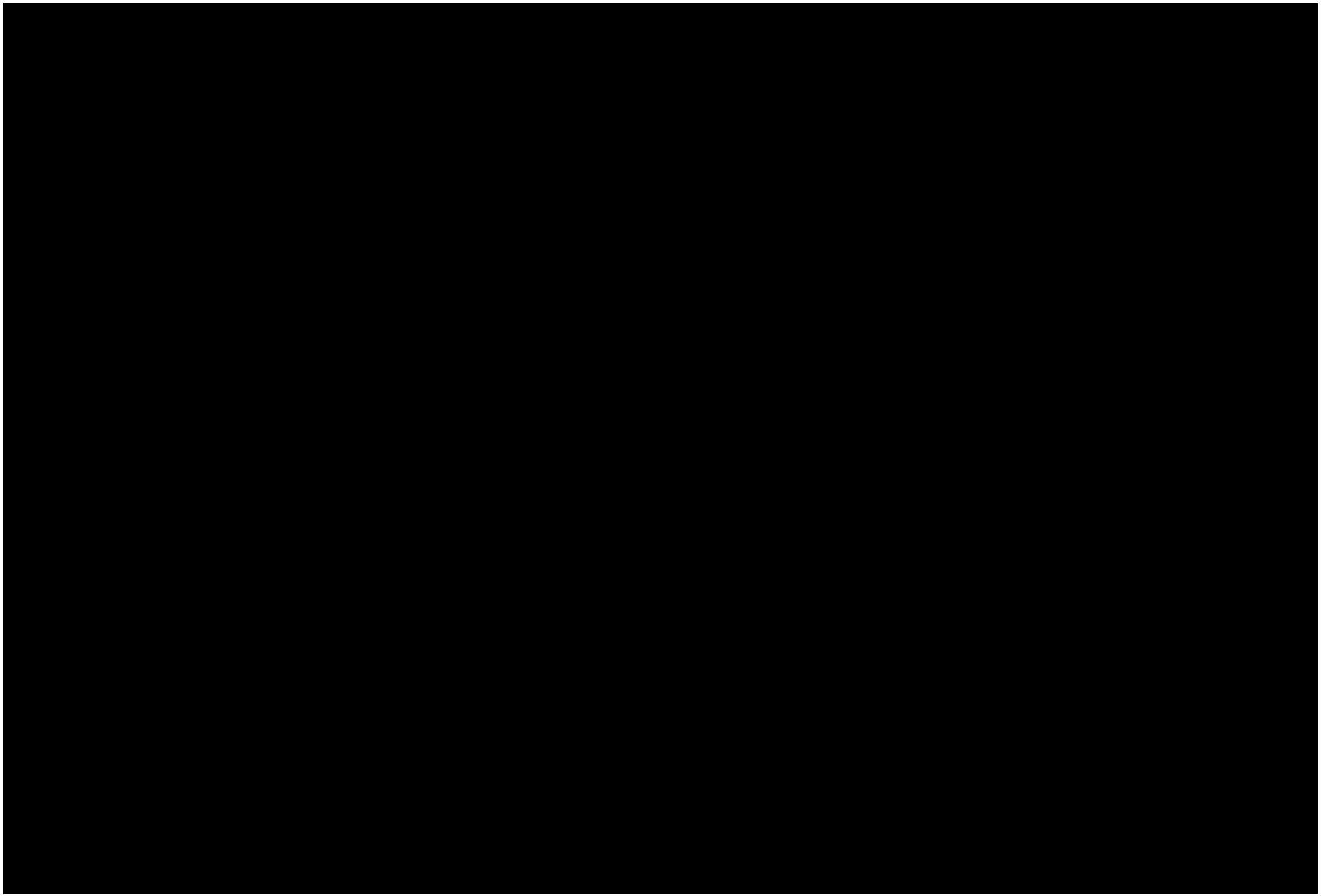

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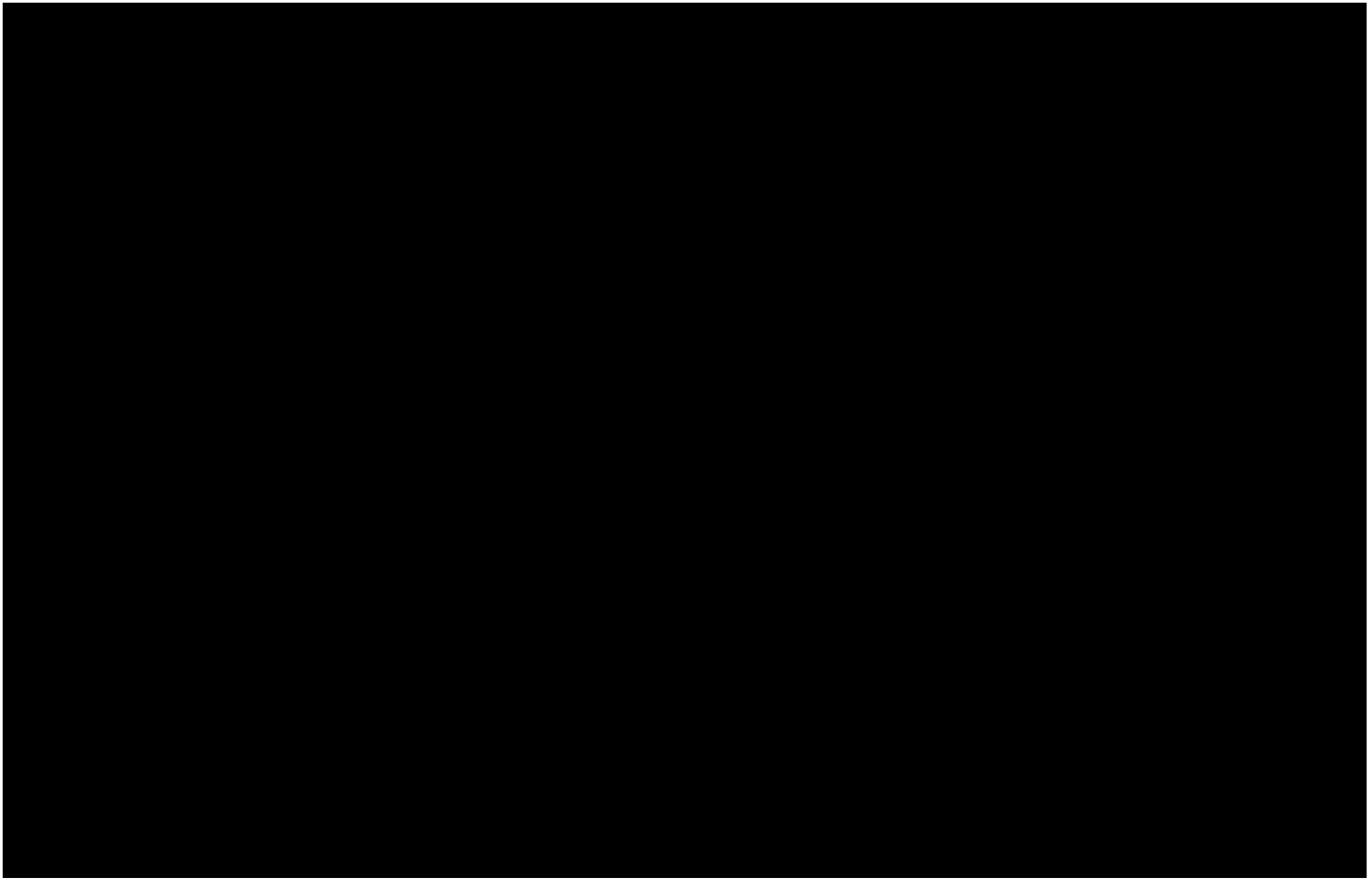

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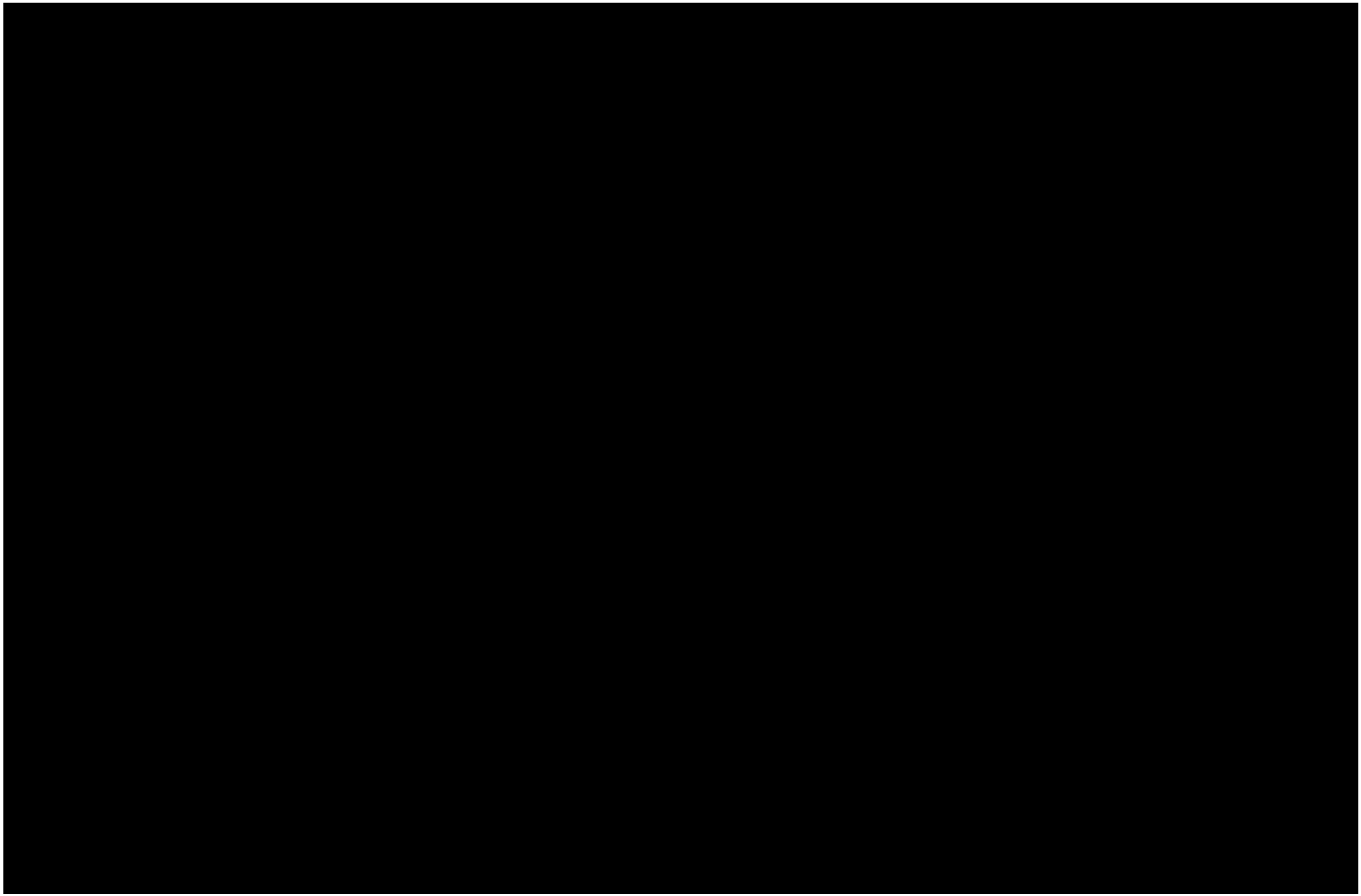

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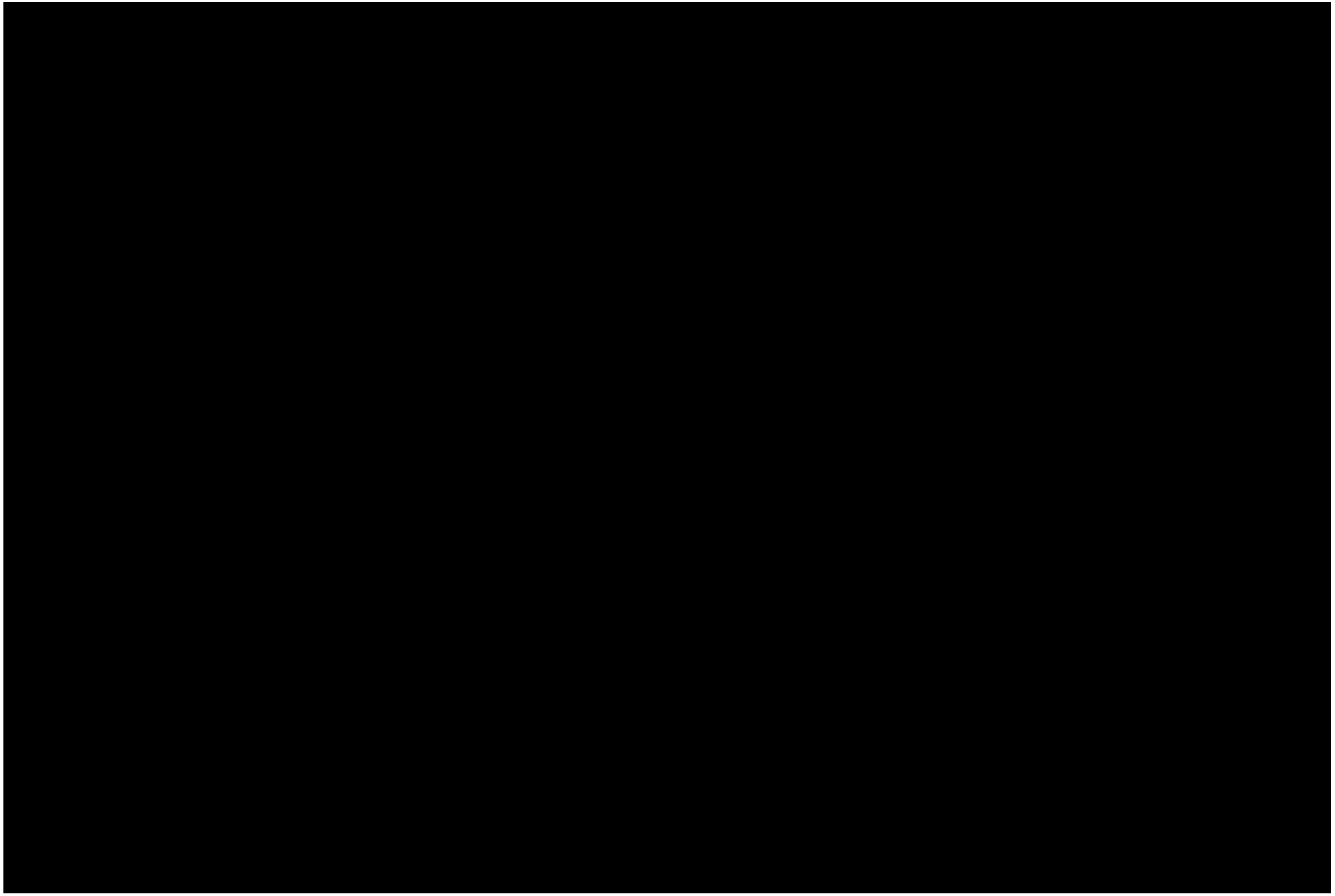

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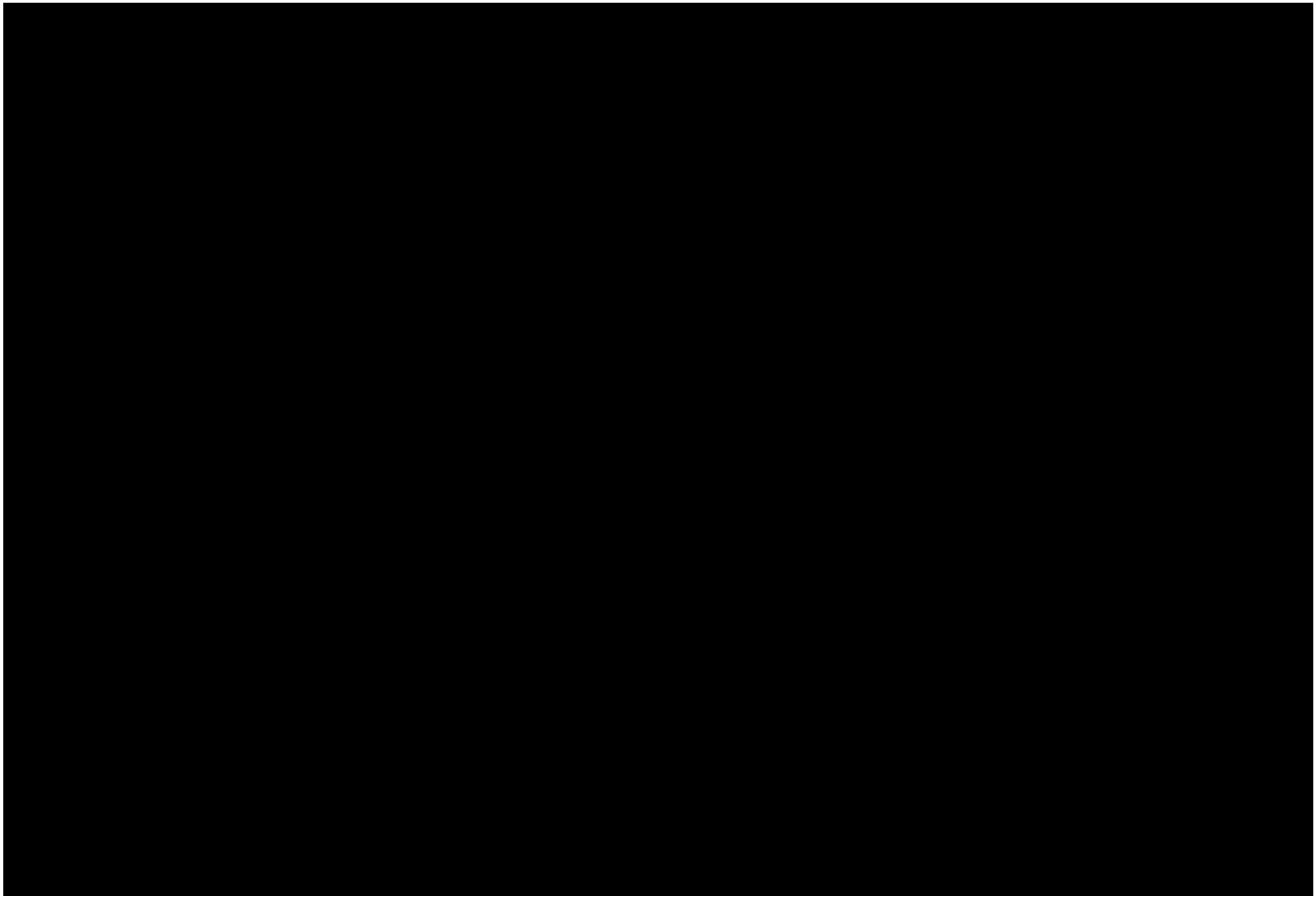

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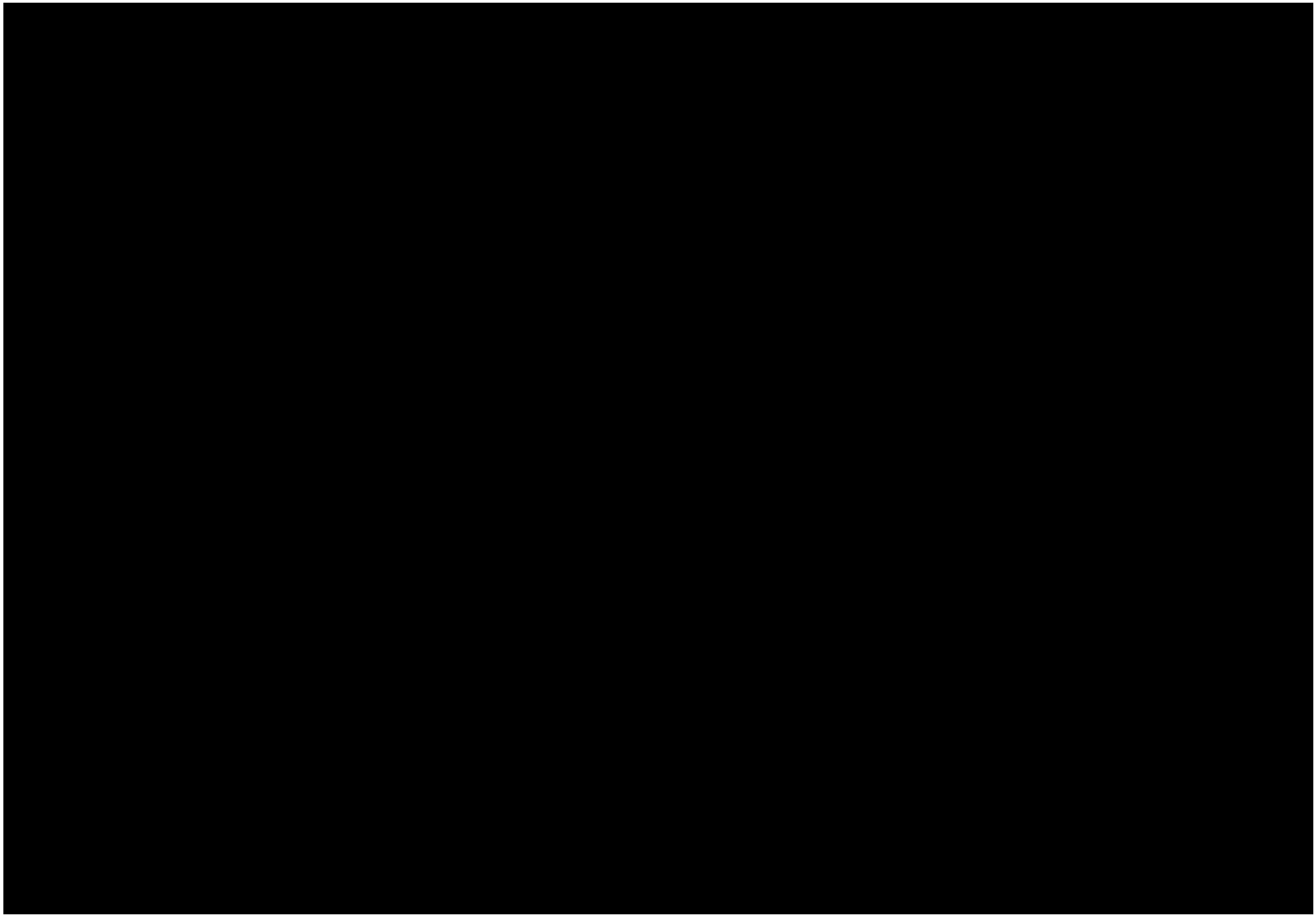

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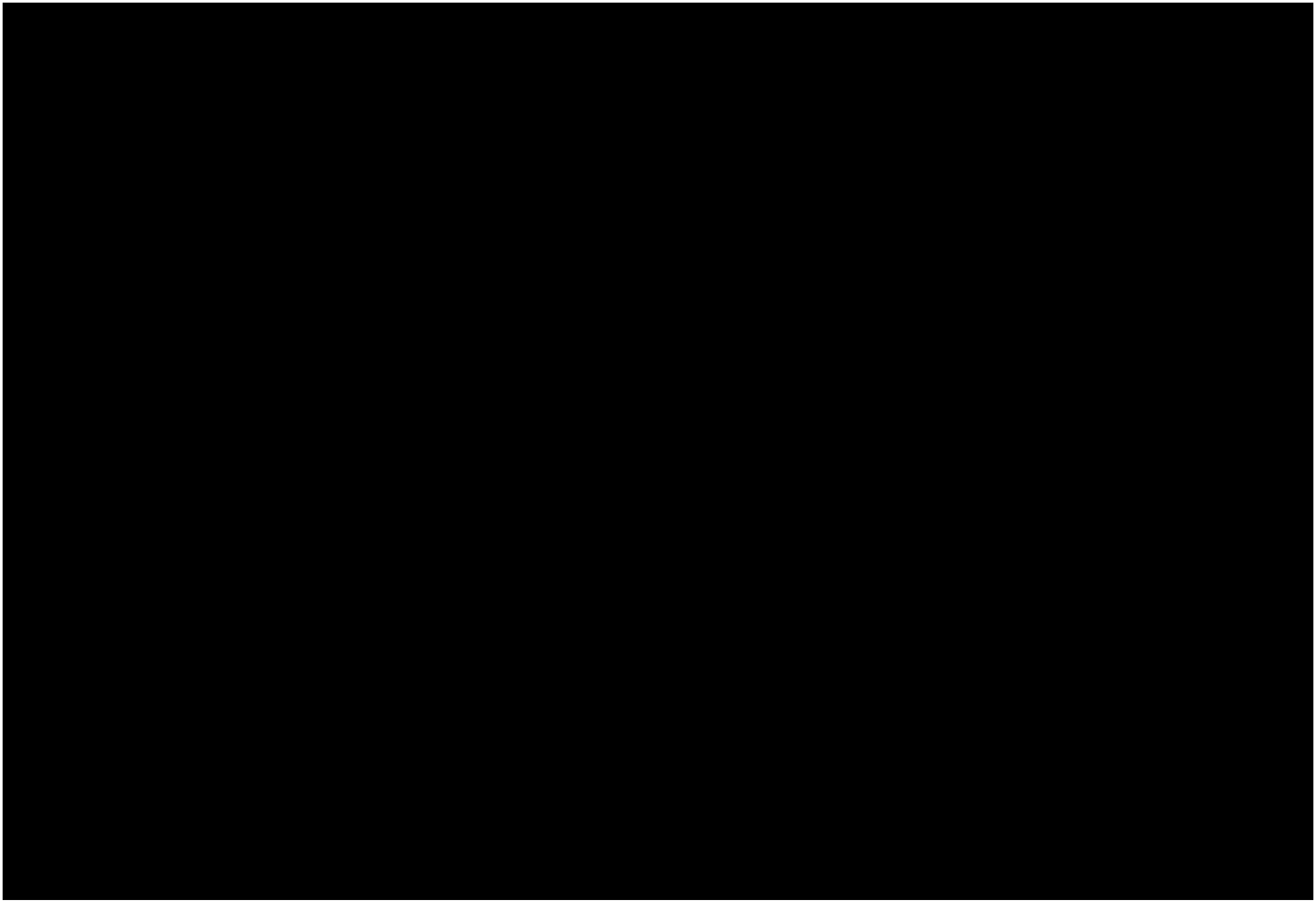

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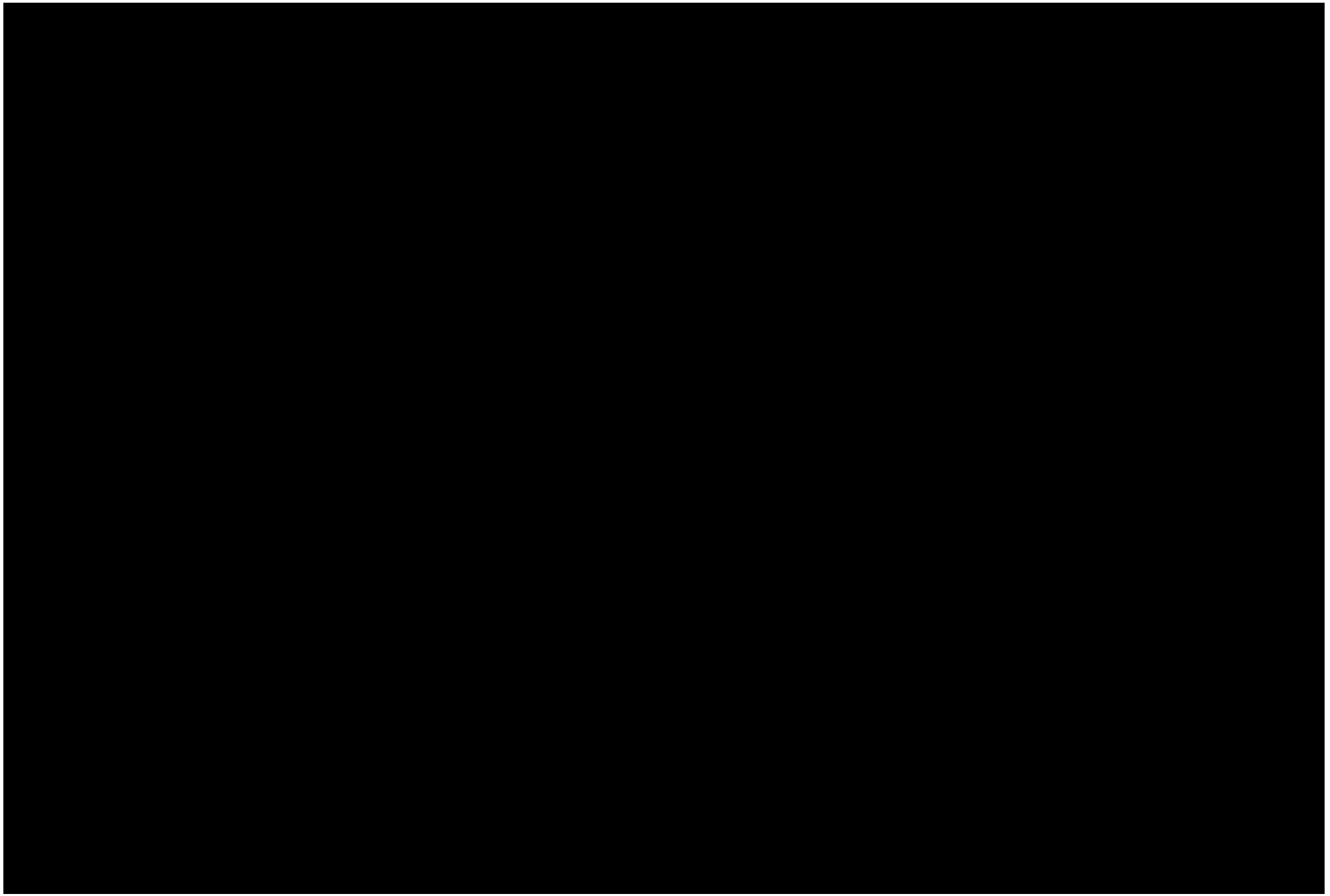

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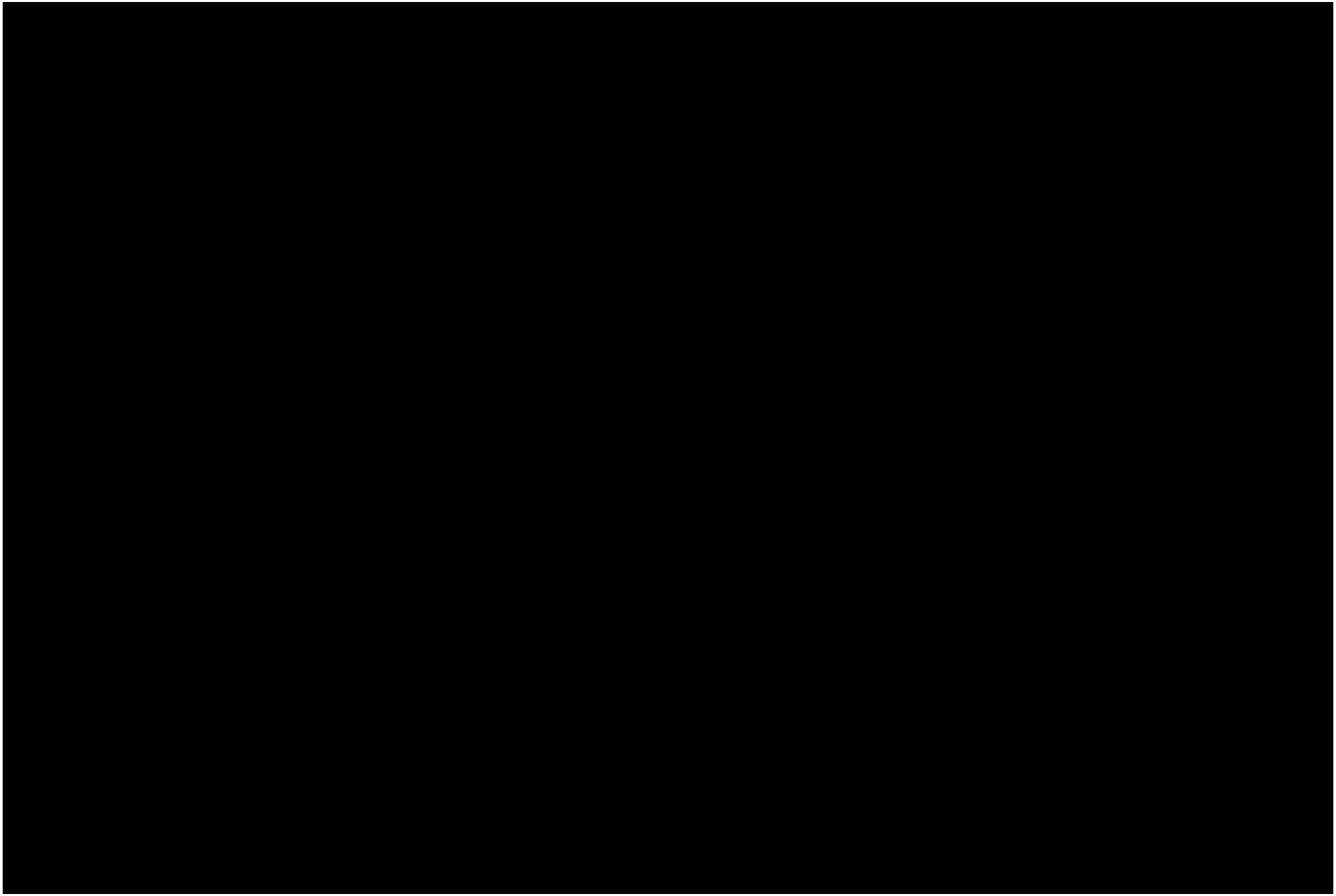

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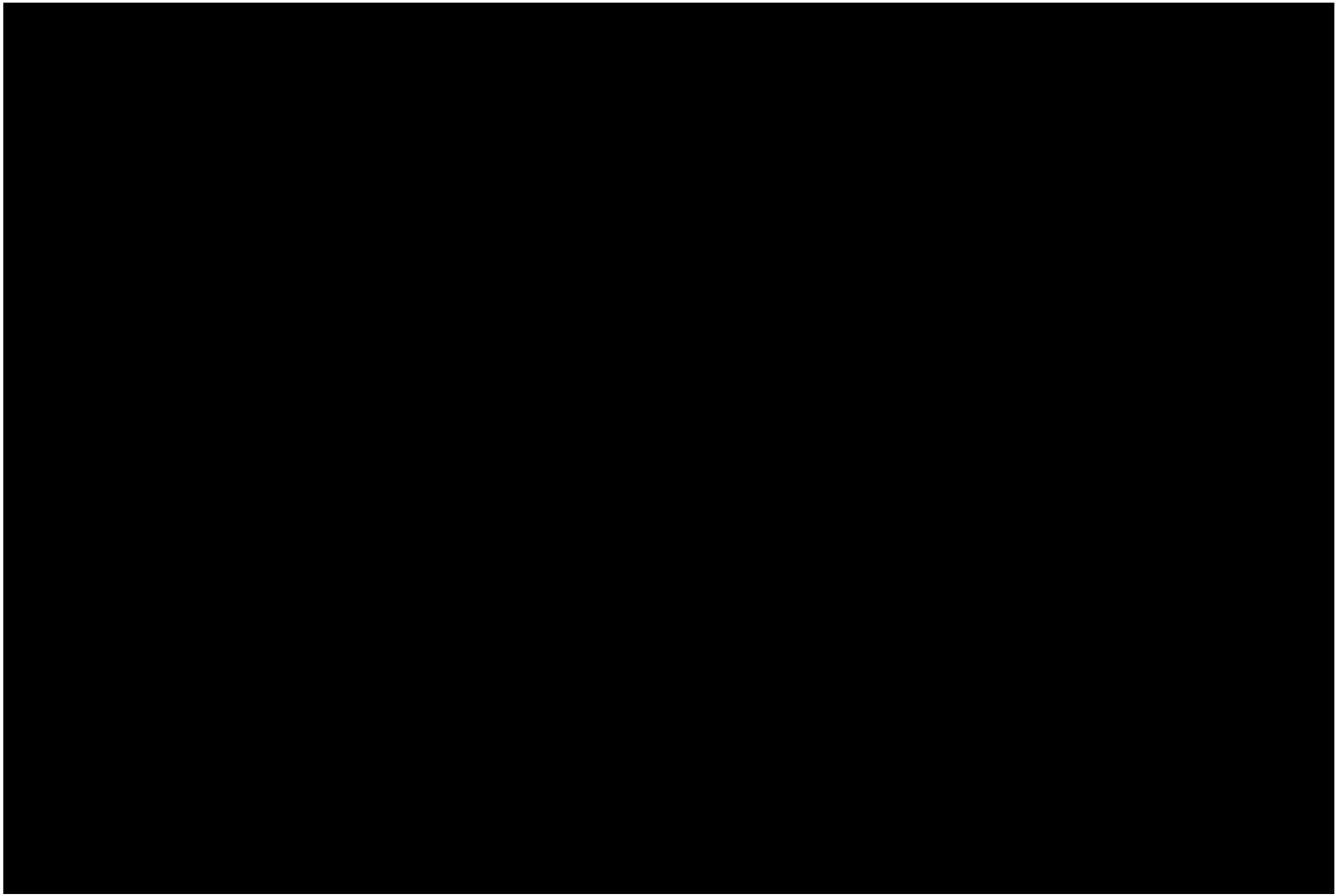

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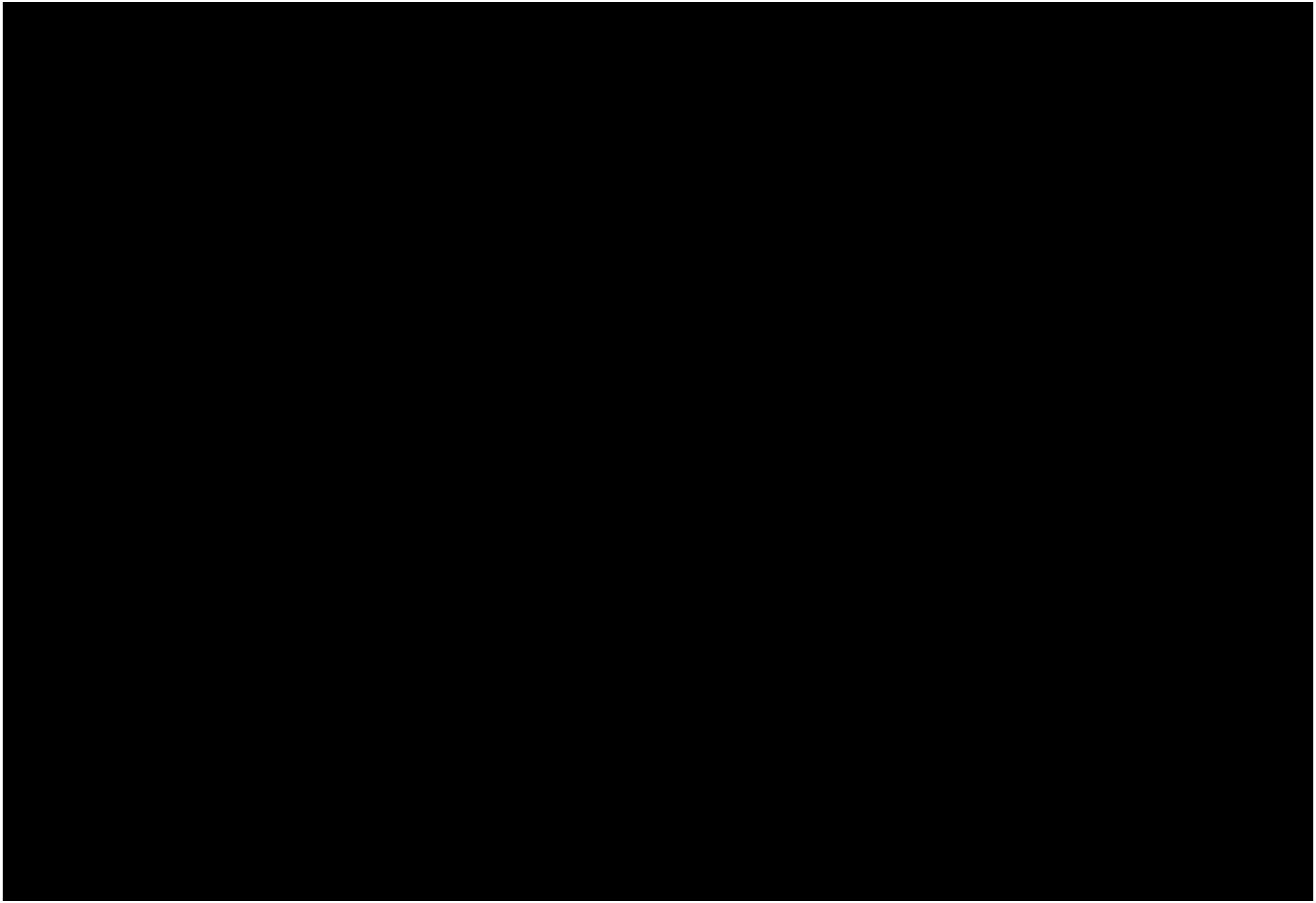

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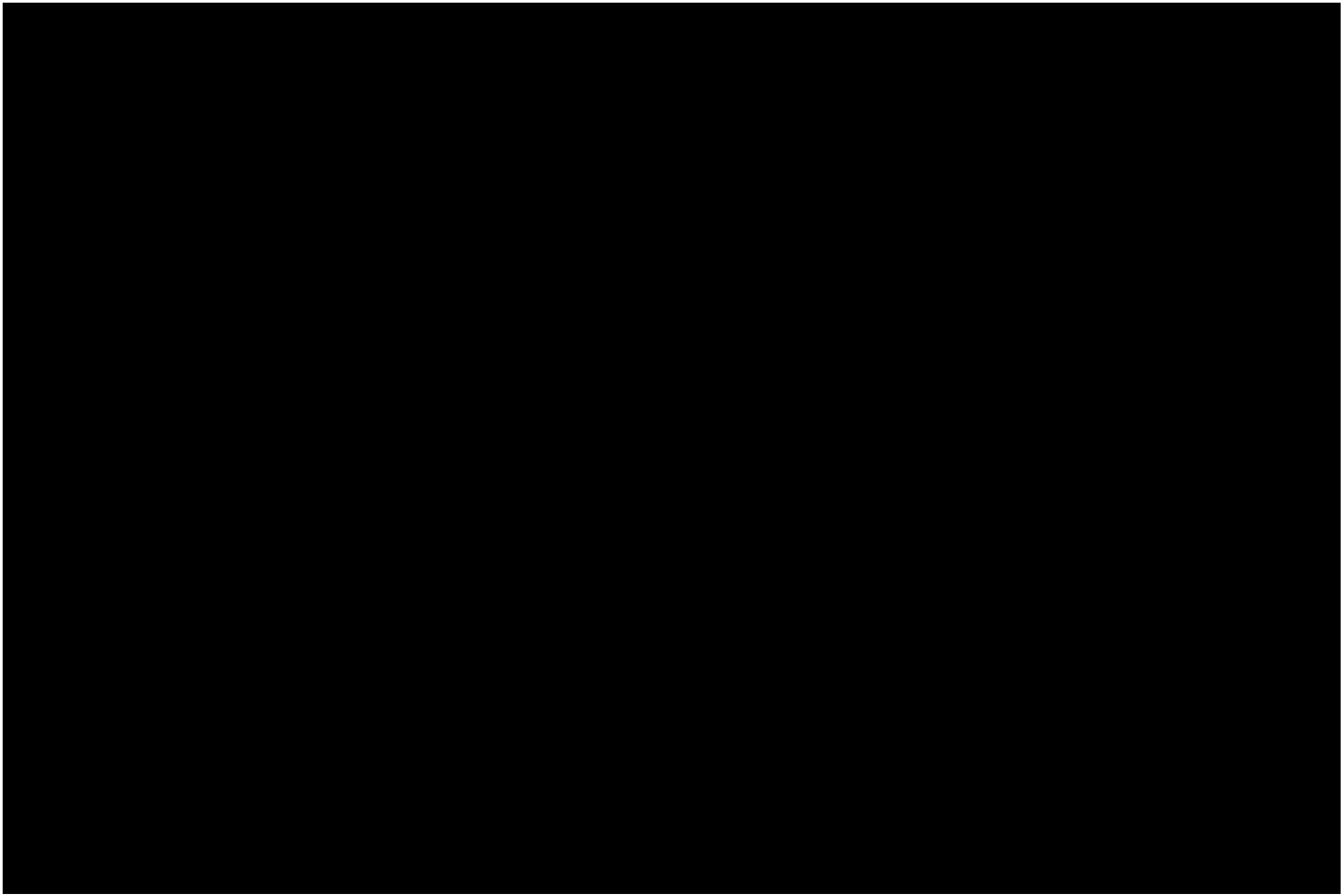

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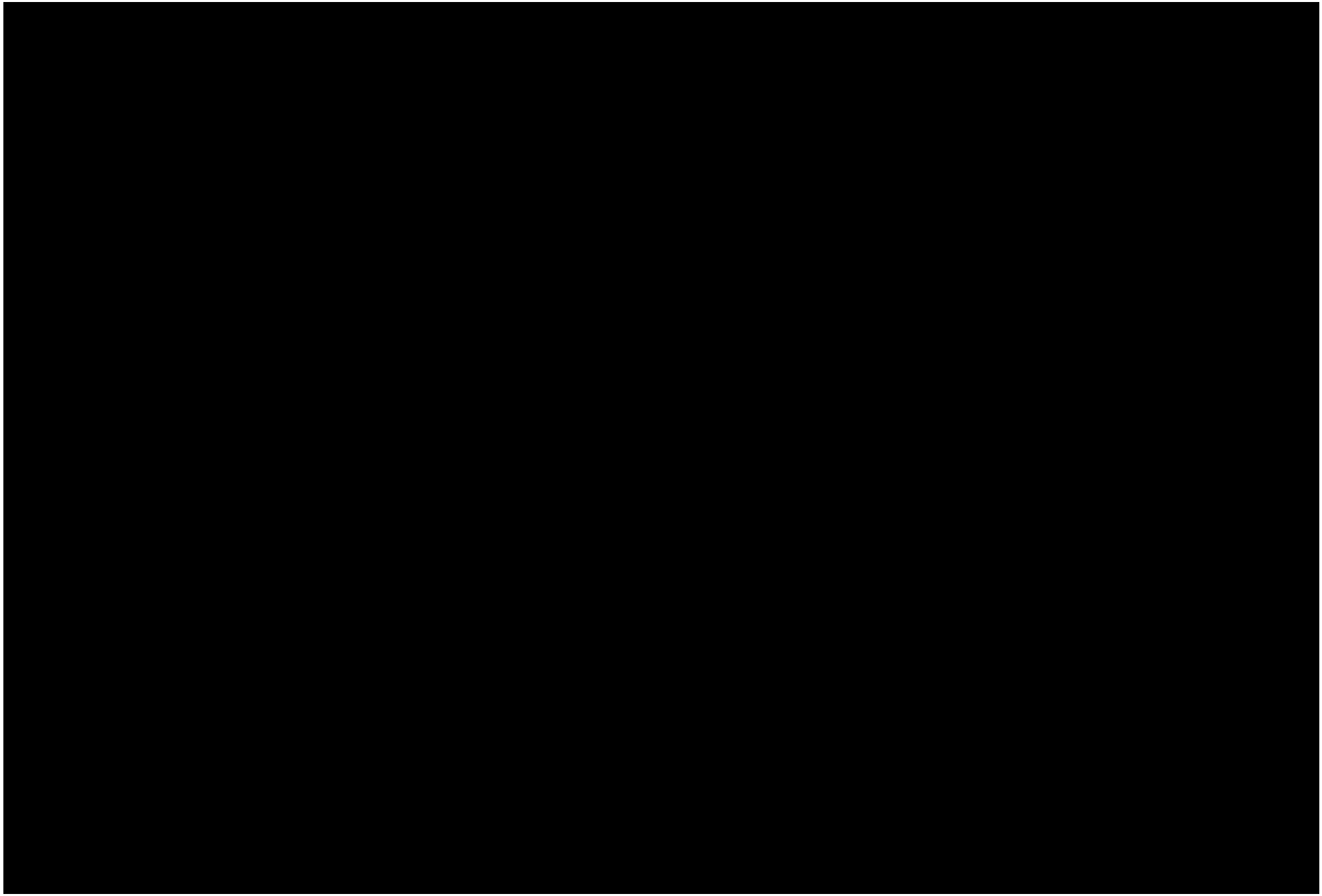

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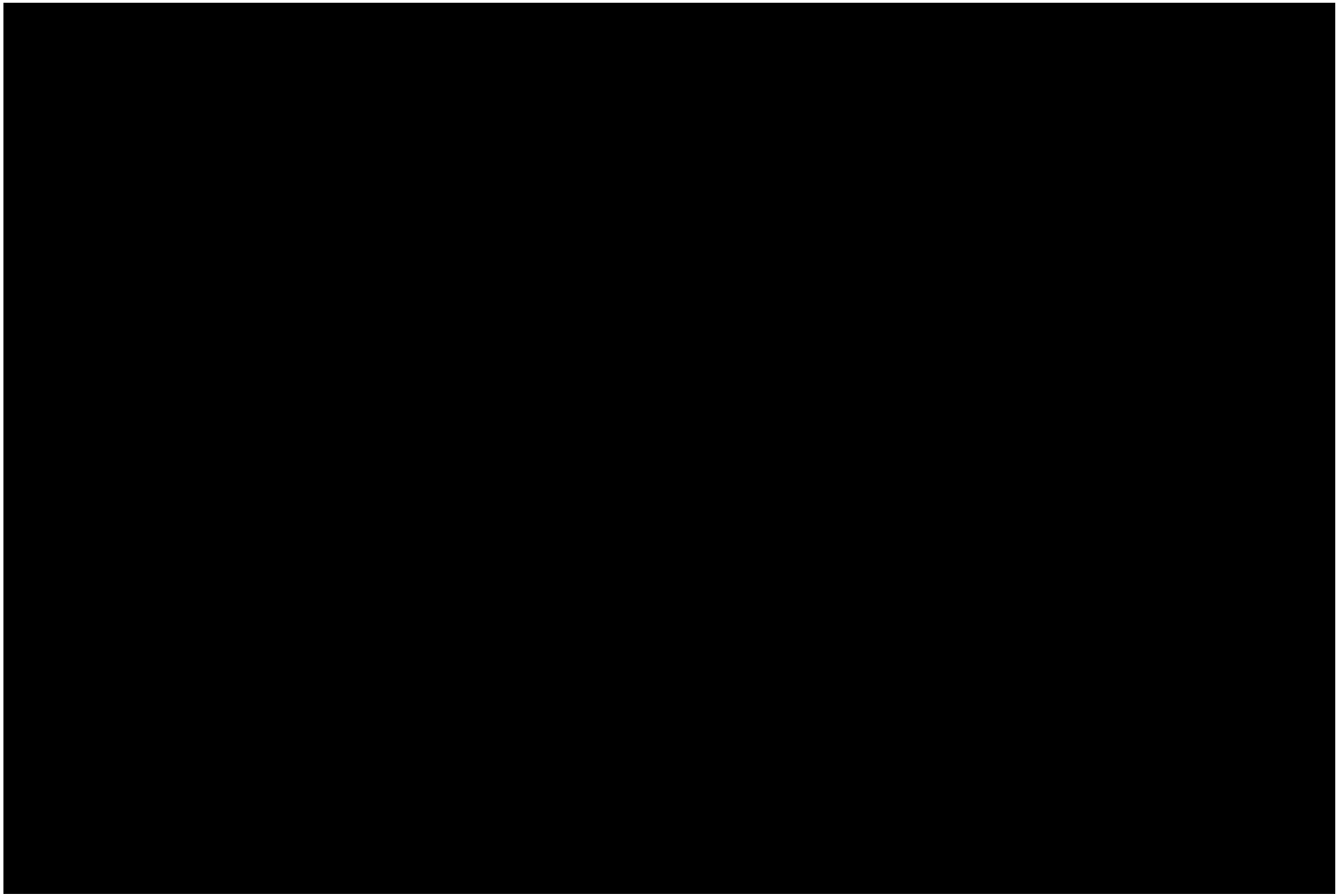

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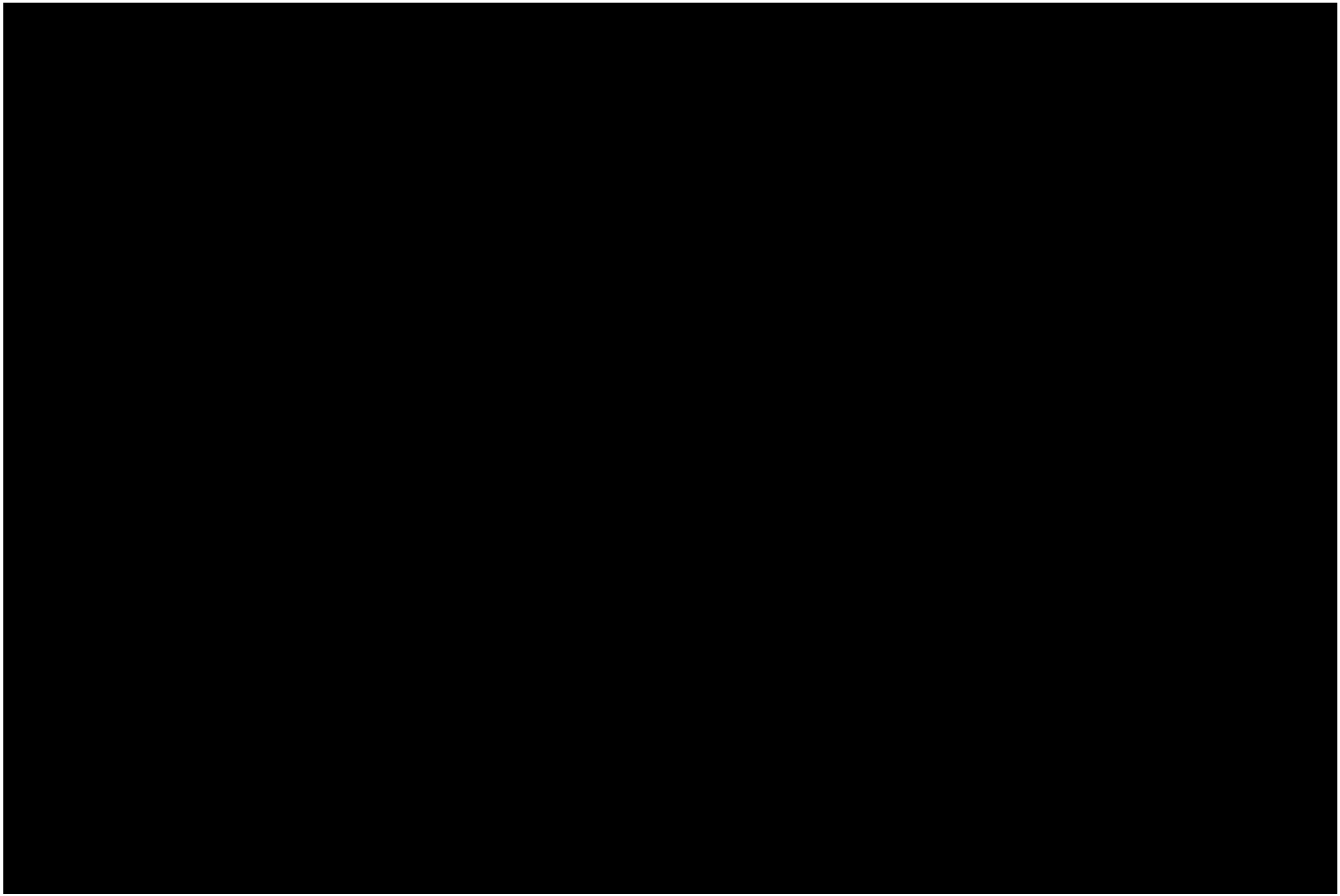

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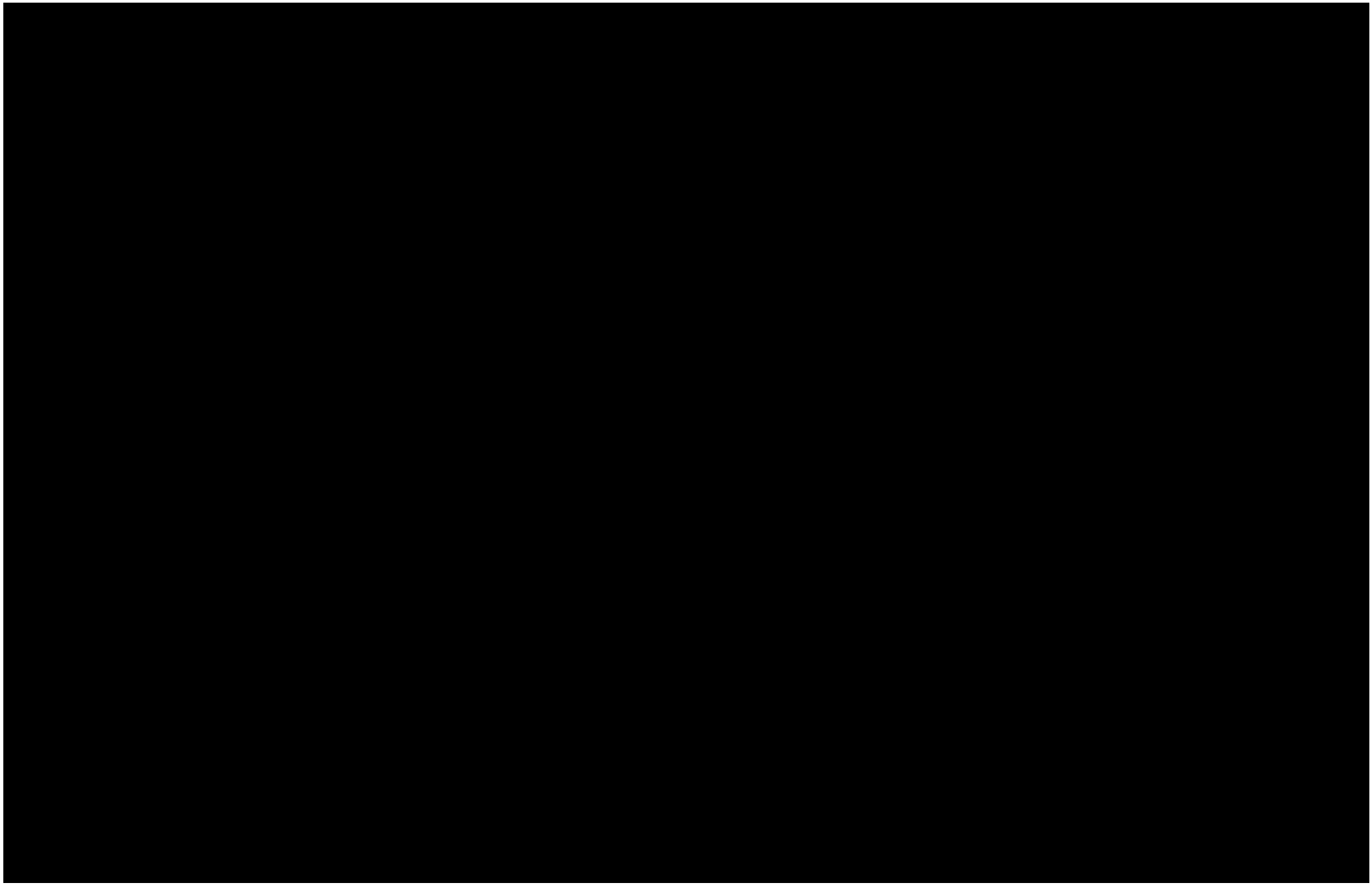

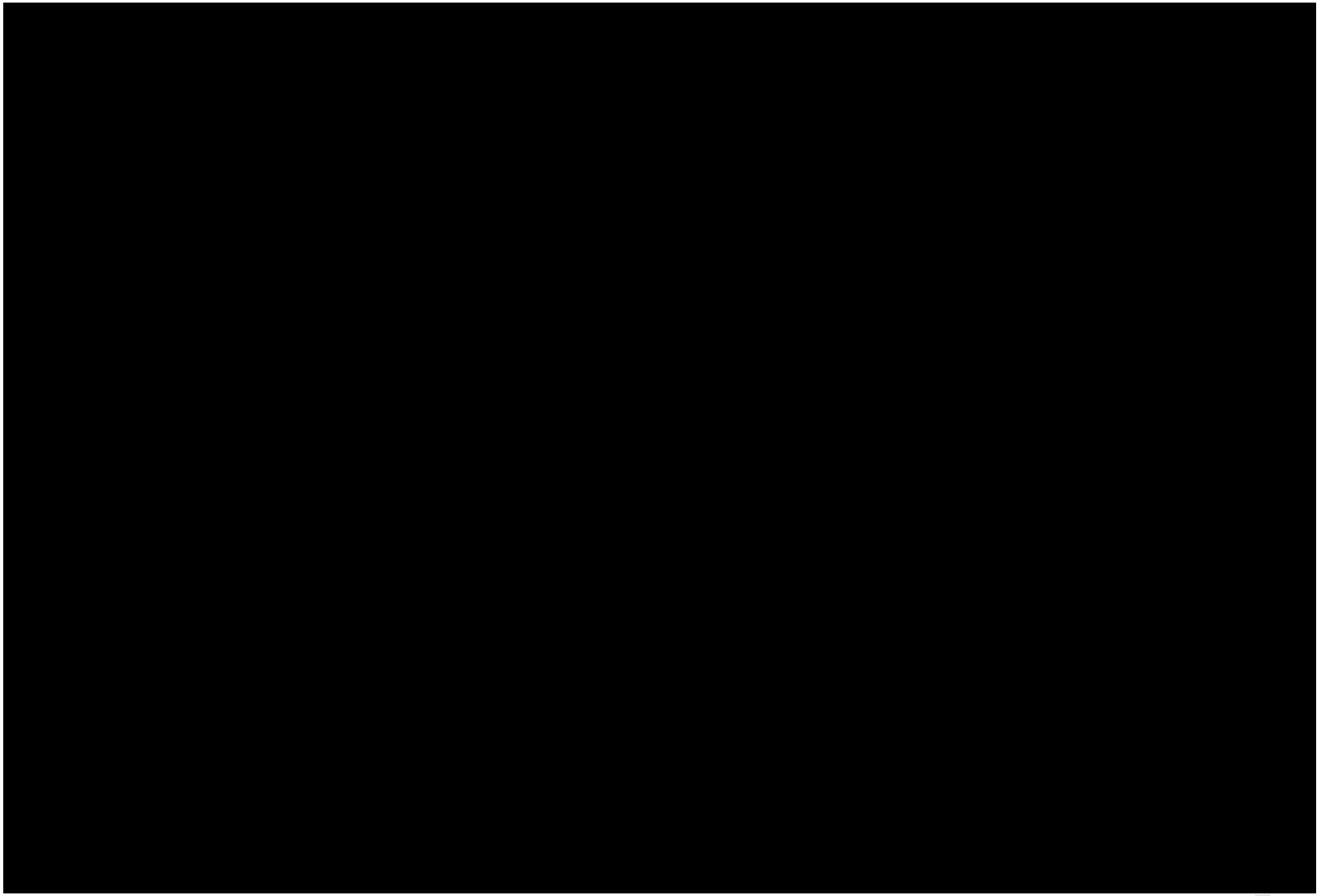

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Appendix N.1.2 28 240306 Draft Tamboran 2024 Work Program Presentation

-----Original Message-----
From: Emily Beresford-Cane [redacted]
Sent: Wednesday, March 6, 2024 2:45 PM
To: [redacted]
Cc: [redacted]
Subject: Draft Tamboran 2024 Work Program Presentation

Hi [redacted]

Please find attached Draft Presentation for the 2024 Work Program meeting to be held in Elliott on the 19th March 2023.

We will bring a number of large maps for the meeting as well.

Appreciate any feedback or questions you have on the attached.

Kind regards

Emily

Tamboran Beetaloo Joint Venture Project Work Program Meeting

March 2024

Confidential

Kyalla 117 N2- NORTHERN TERRITORY AUSTRALIA

Agenda

1. Purpose of Work Program Meeting
2. Beetaloo Roadmap and Exploration – recap
3. 2023 work completed/underway
4. Proposed 2024 work program
5. Appraisal Gas Project
6. New sacred site clearances
7. Approvals - EMP's and Water Extraction License
8. Near term opportunities
9. Next steps and questions

Purpose of Work Program Meeting

- Purpose of Work Program meeting is to talk through what exploration activity has occurred on the Exploration Permits throughout 2023
- Talk through the results of 2023 Exploration Activity
- Provide an overview of the exploration activity planned for 2024
- Talk about what Government approval documents have or will be provided to the NLC

About Tamboran

Introducing Tamboran

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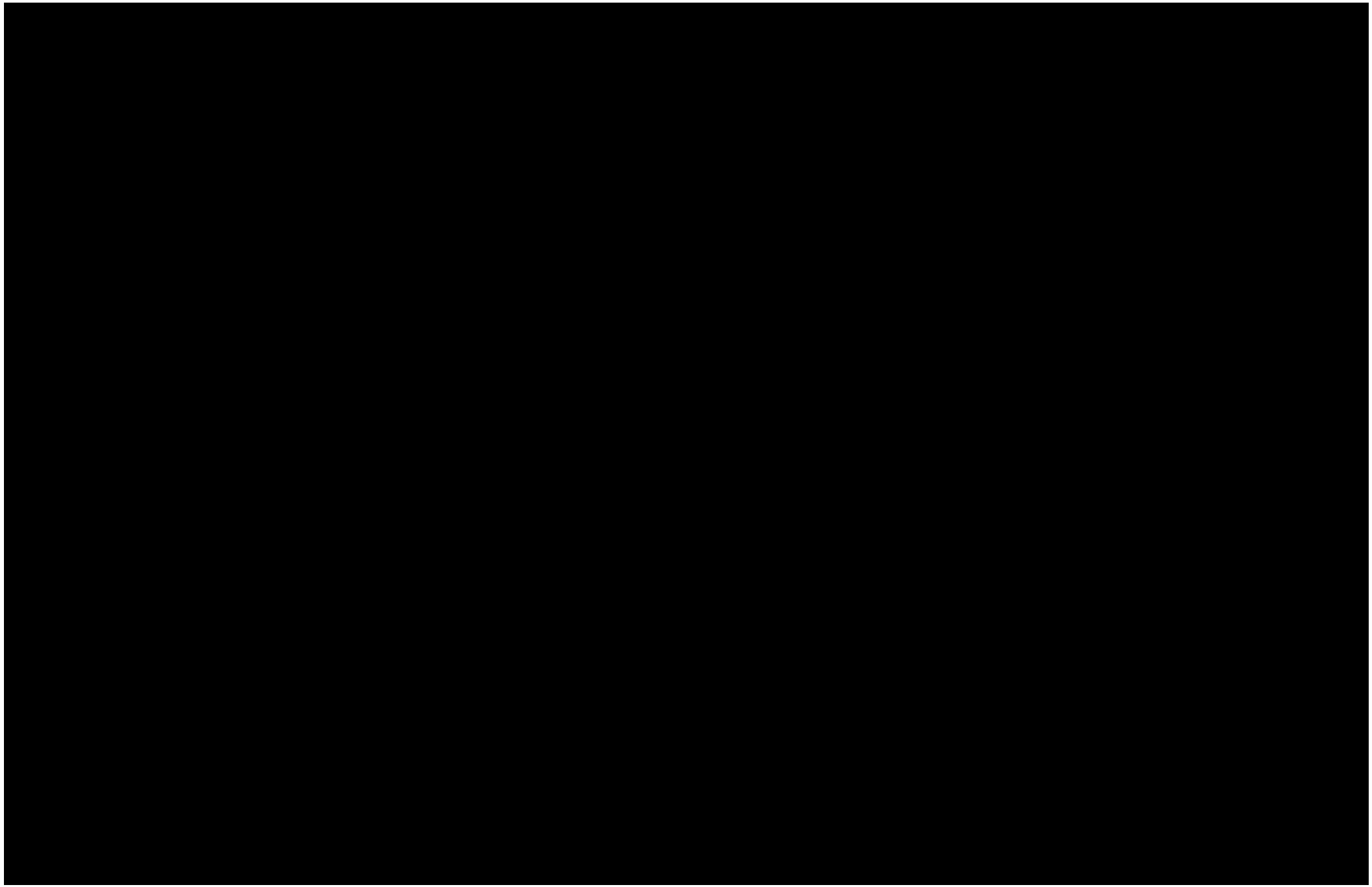
To play a role in the global energy transition by investing in the development of low CO2 unconventional natural gas resources in the Beetaloo Sub-basin of the Northern Territory of Australia and to become a Net Zero carbon emissions gas producer for our equity share of Scope 1 and Scope 2 emissions when the Company achieves commercial gas sales.

Strategy

- Target is to become a Net Zero equity Scope 1 & 2 emissions producer
- Focused, high growth Beetaloo strategy
- High quality assets with significant scale
- Low-cost development targeting multiple markets, premium pricing
- Expertise in unconventional E&P development

Sustainability

- Health & Safety
- Climate Change
- Environment
- People
- Community
- Economic Sustainability



Operations update – 2023 was a big year for the Beetaloo

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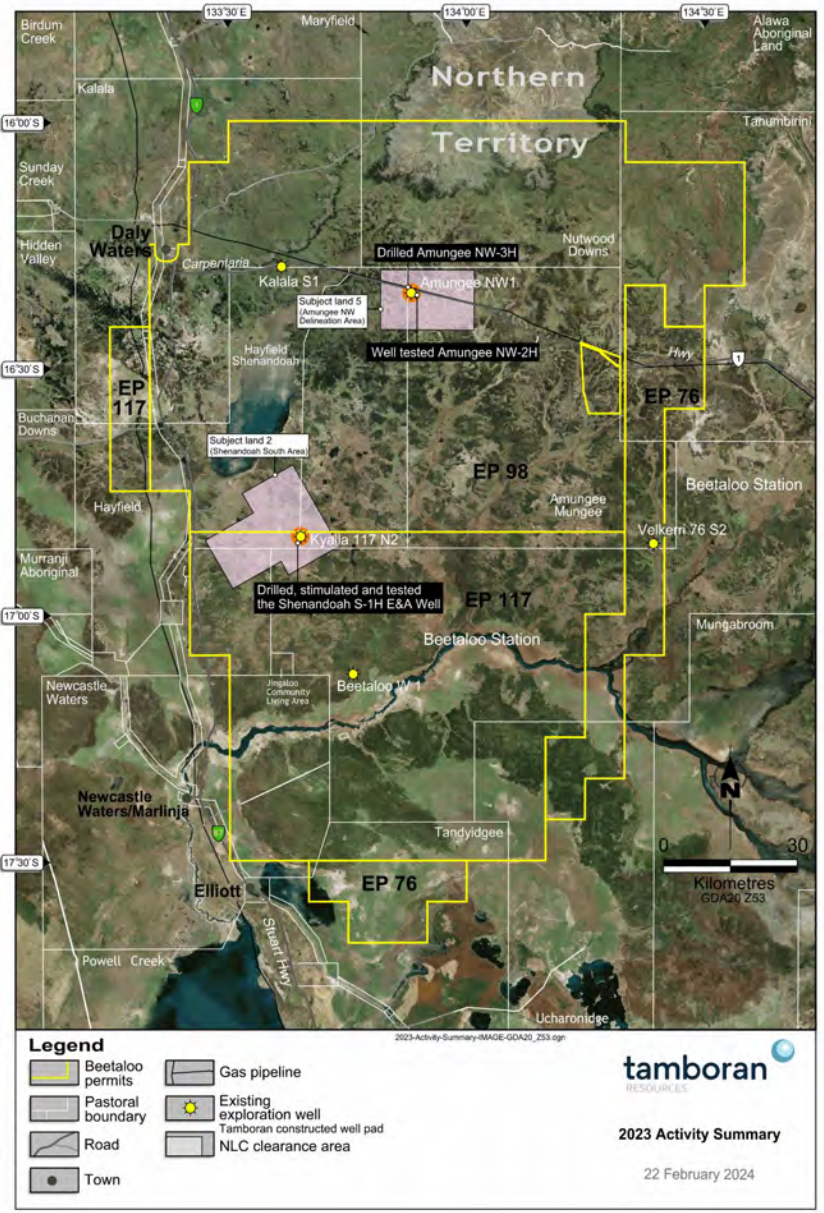
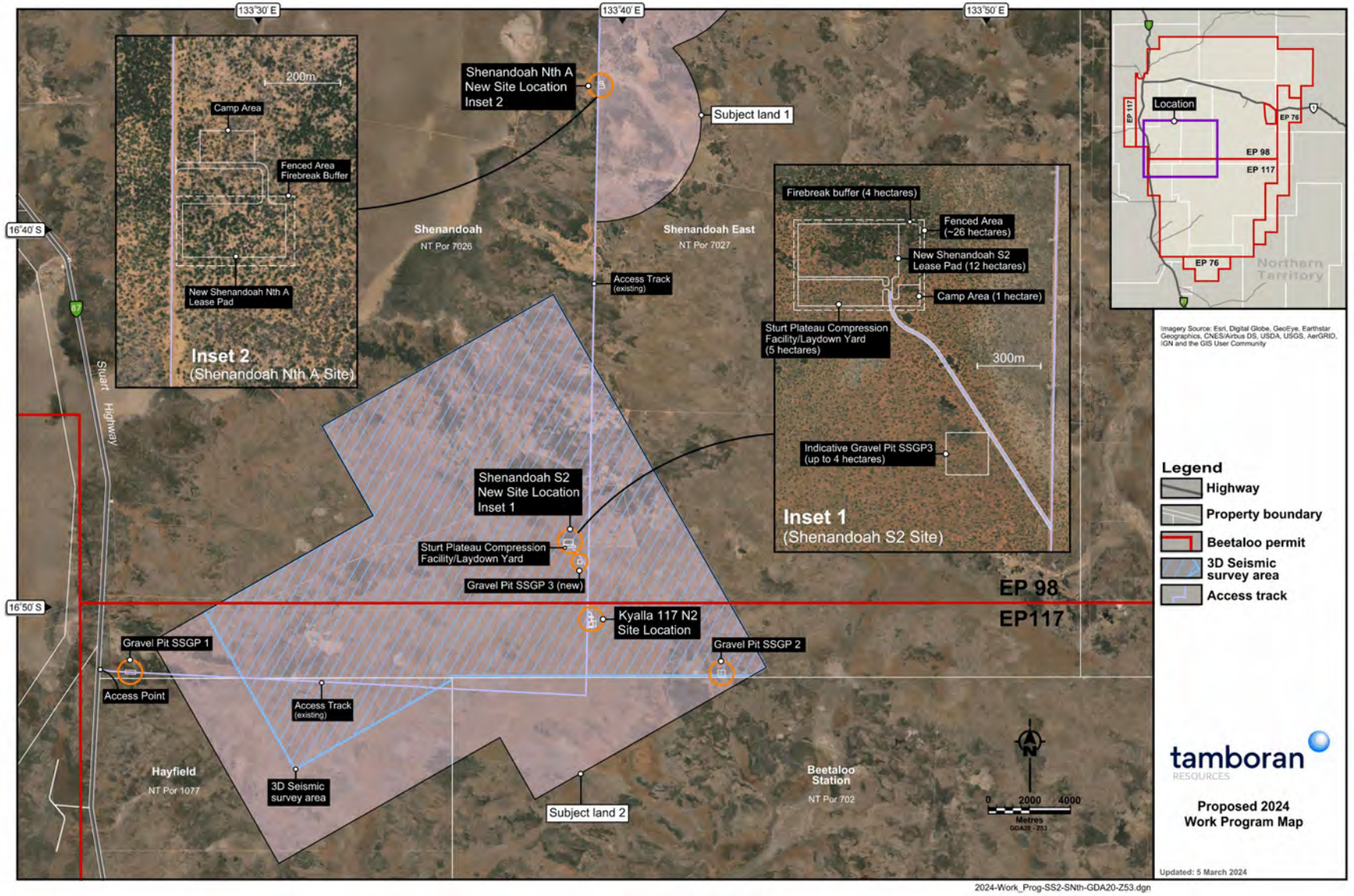


Proposed 2024 Work Program



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tamboran RESOURCES

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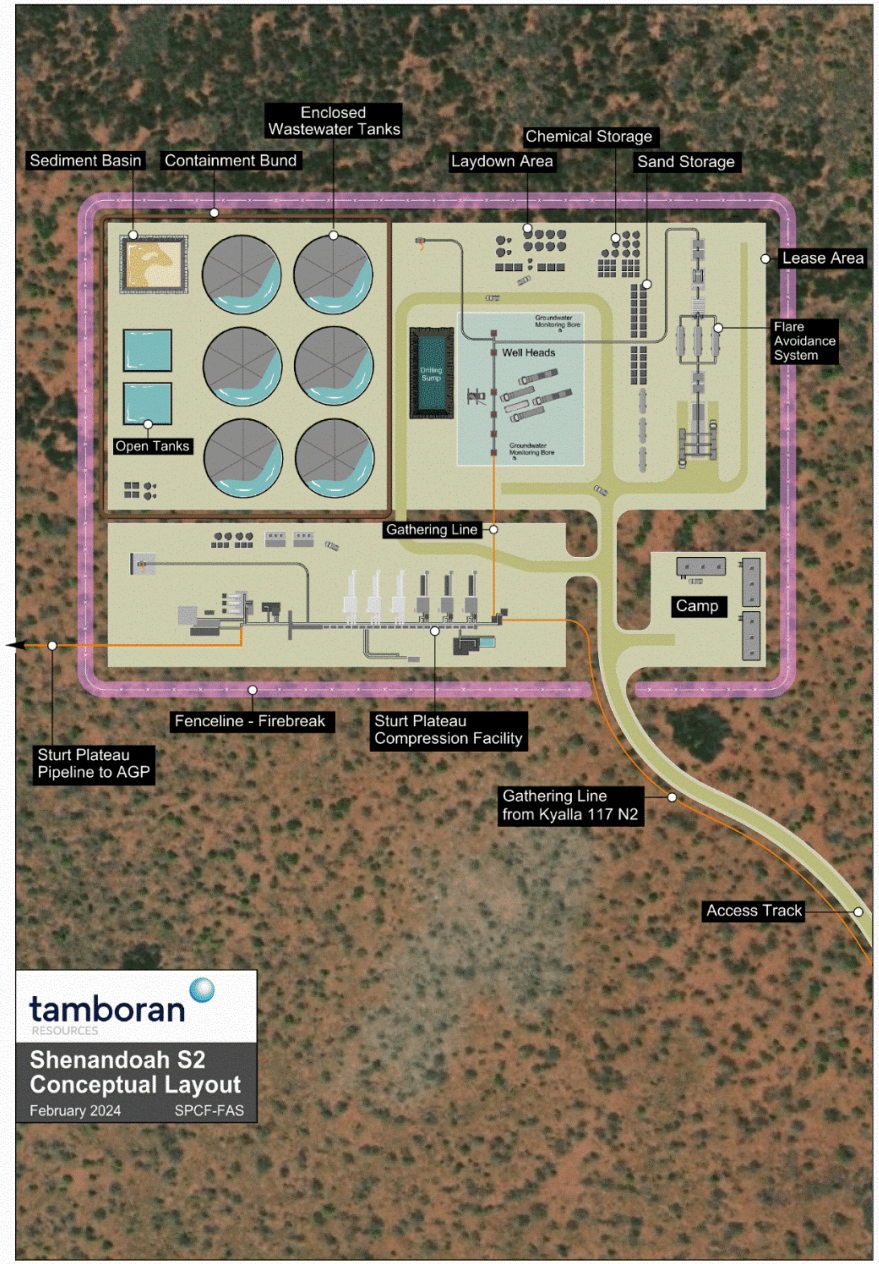
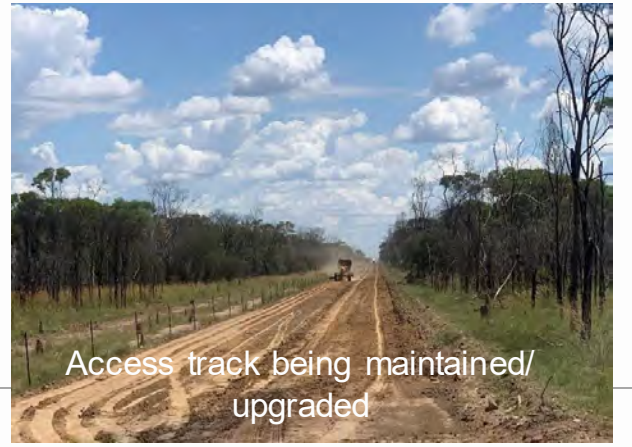


Lease pad being constructed with water bore being drilled

Drill sump being dug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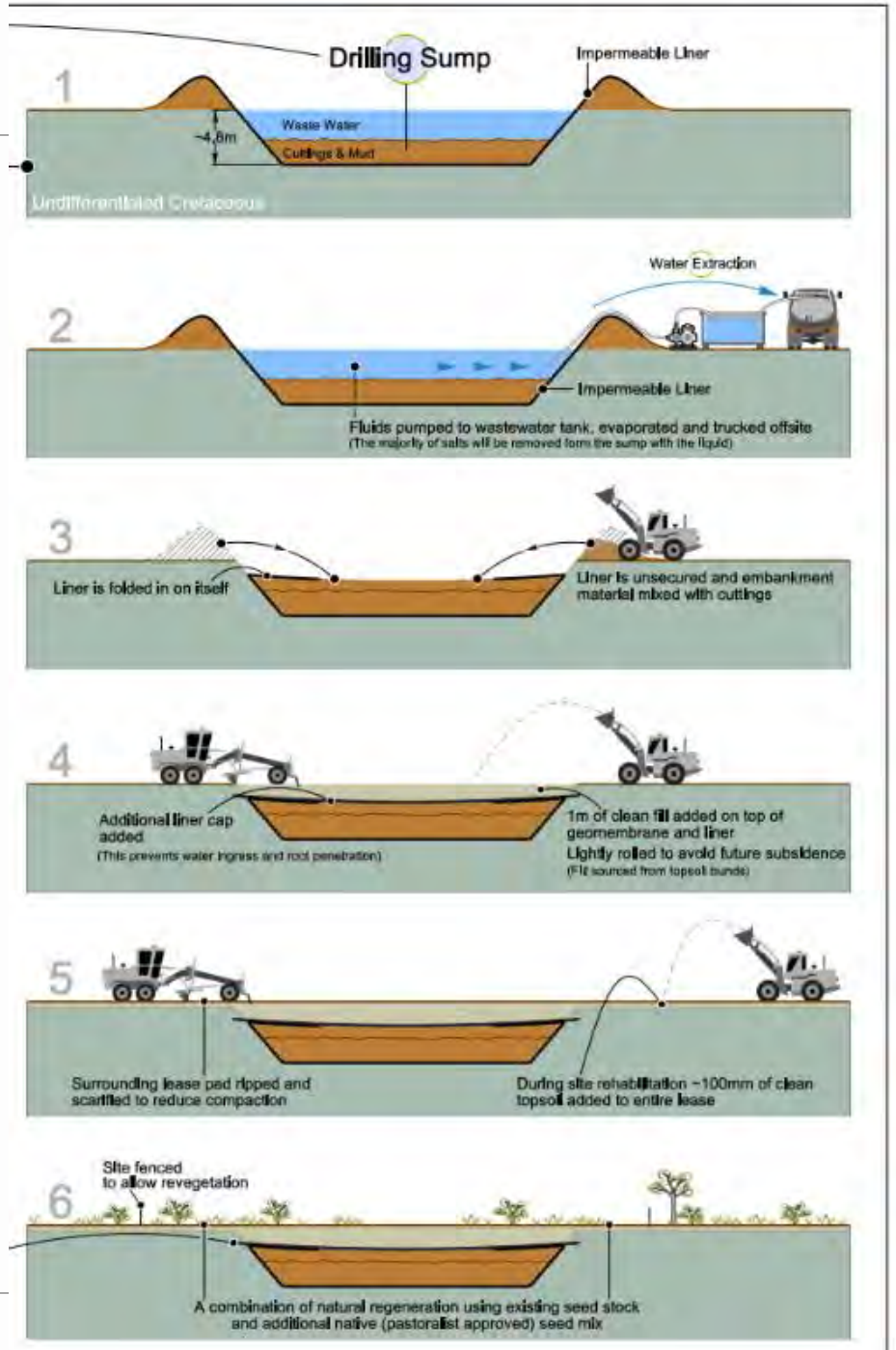
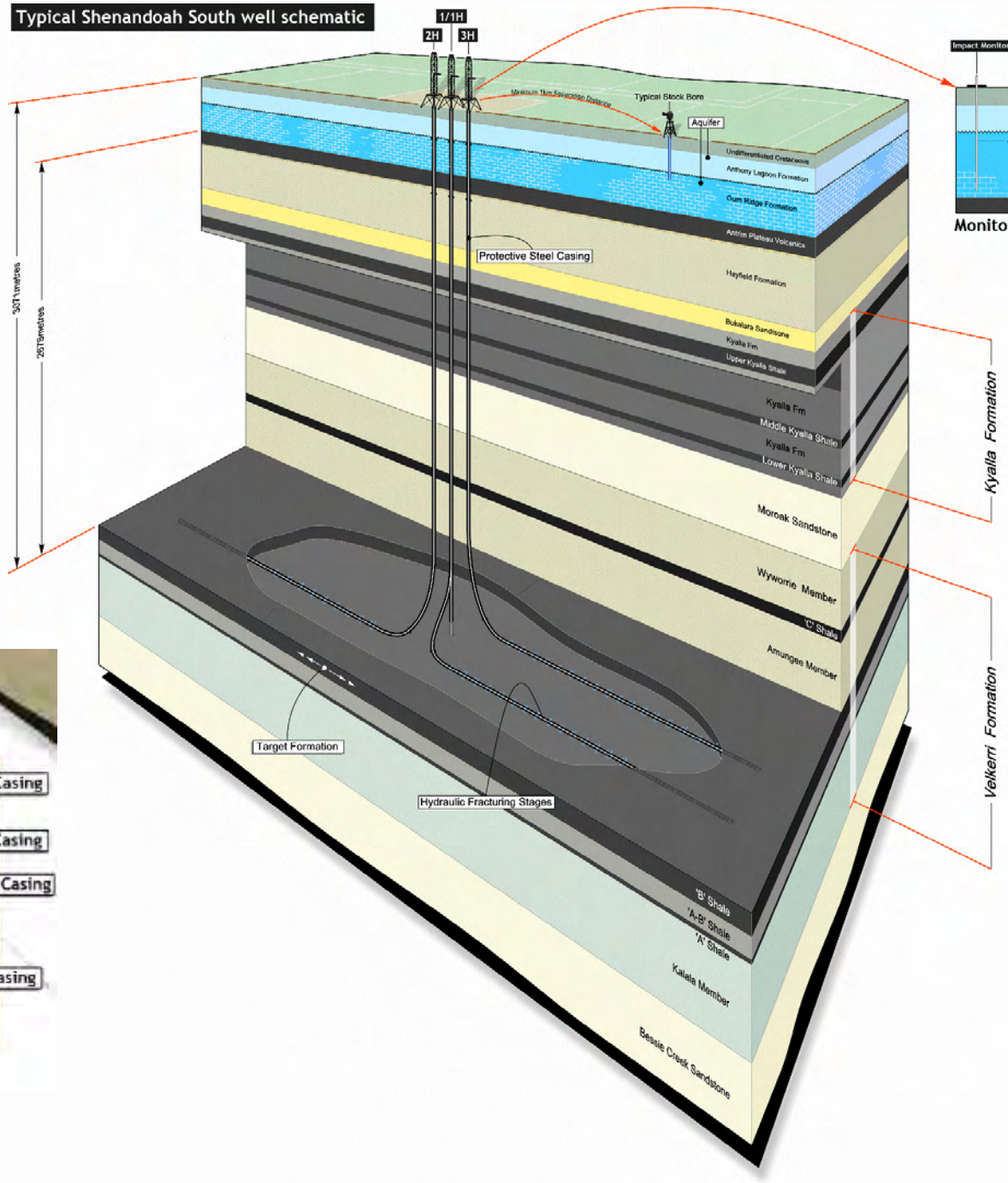
- Cuttings from rocks is the largest source of waste.
- Salt is the main compound which can be managed through capping.
- Vegetation will regrow on the capped sump similar to landfills.

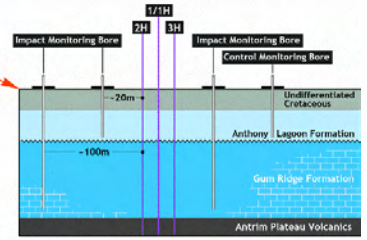
Sump at end of drilling with cuttings, mud and fluid

Water from sump removed and trucked offsite- material blended, lined and then buried



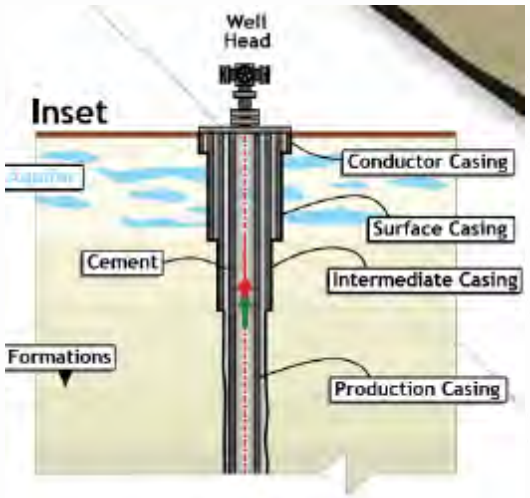
tamboran RESOURCES





Monitoring Bore Detail

Multiple string of cement and steel protect aquifers

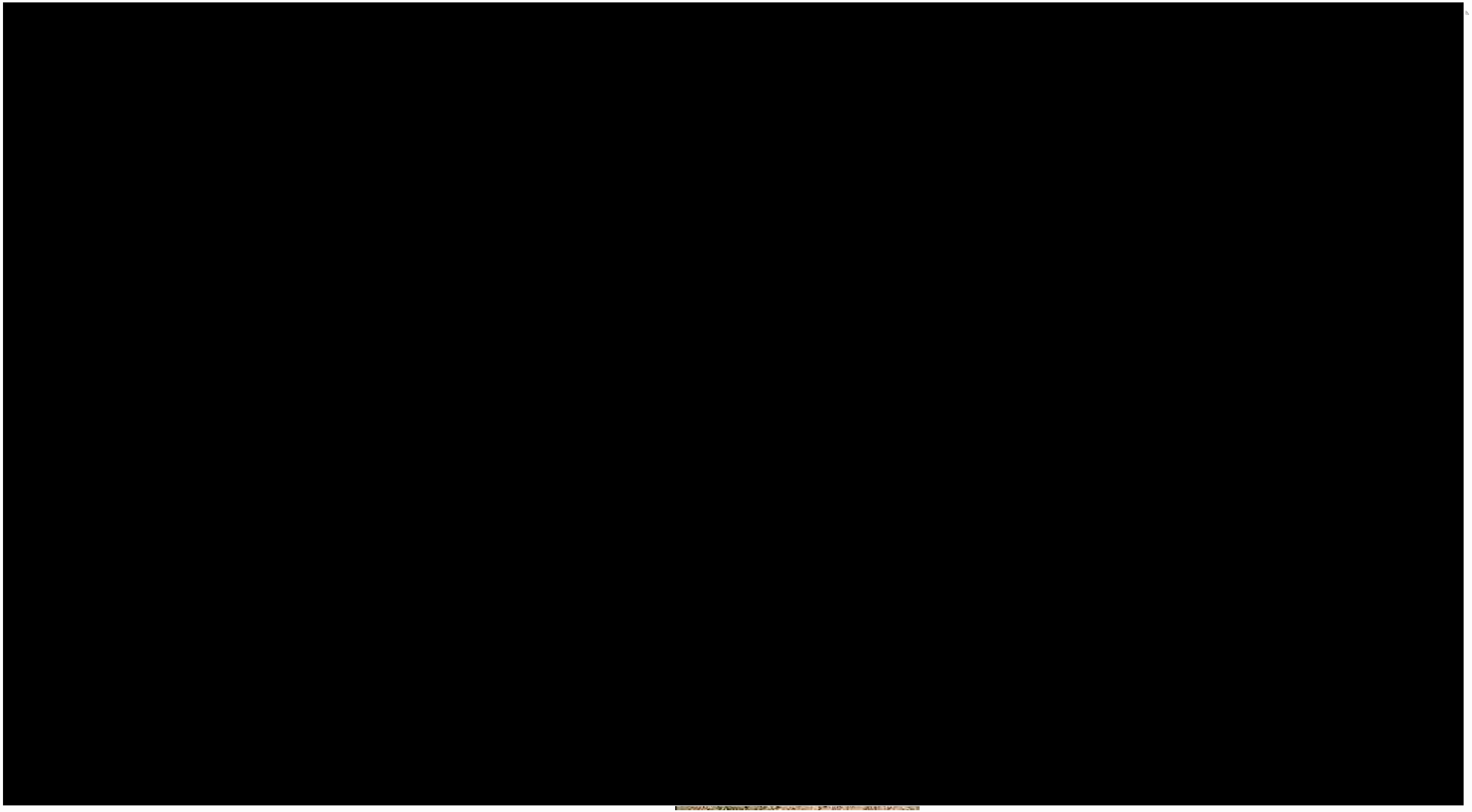


- Typical well schematic- noting Shenandoah Nth A will not have a horizontal
- Wells targeting the Velkerri B –shale
- Approximately 3,100m below ground level
- ~2700m below the closest aquifer
- Groundwater is monitored quarterly

Shenandoah North A

- Located within Subject Land 1
- Construction of new 3 ha Shenandoah NA including lease pad, camp pad and access tracks, land clearing and civil construction
- 2024/2025
- Drilling water bores
- Drilling of a vertical stratigraphy well
- Example provided is Amungee NW 1 being drilled

Drilling rig



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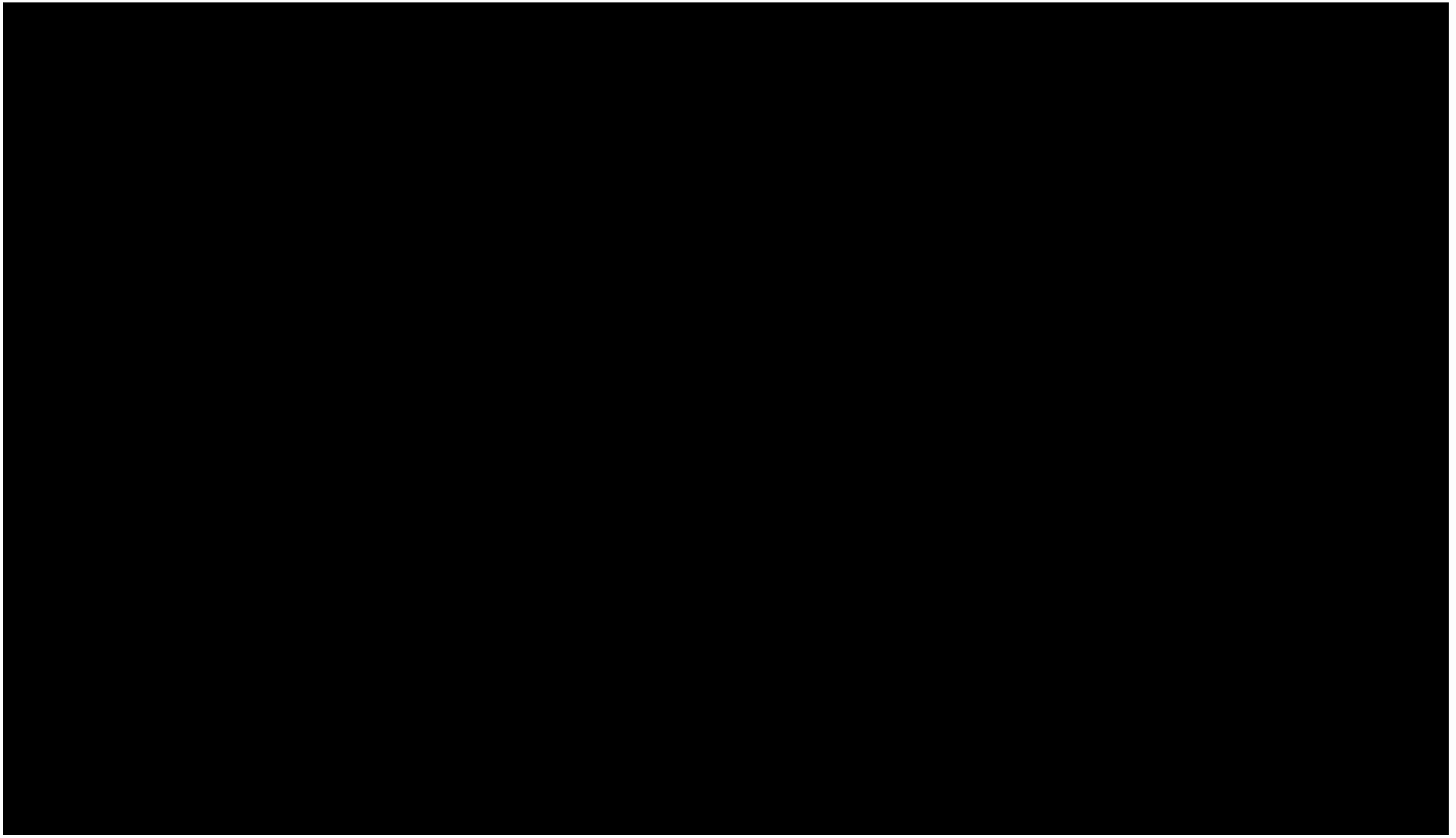
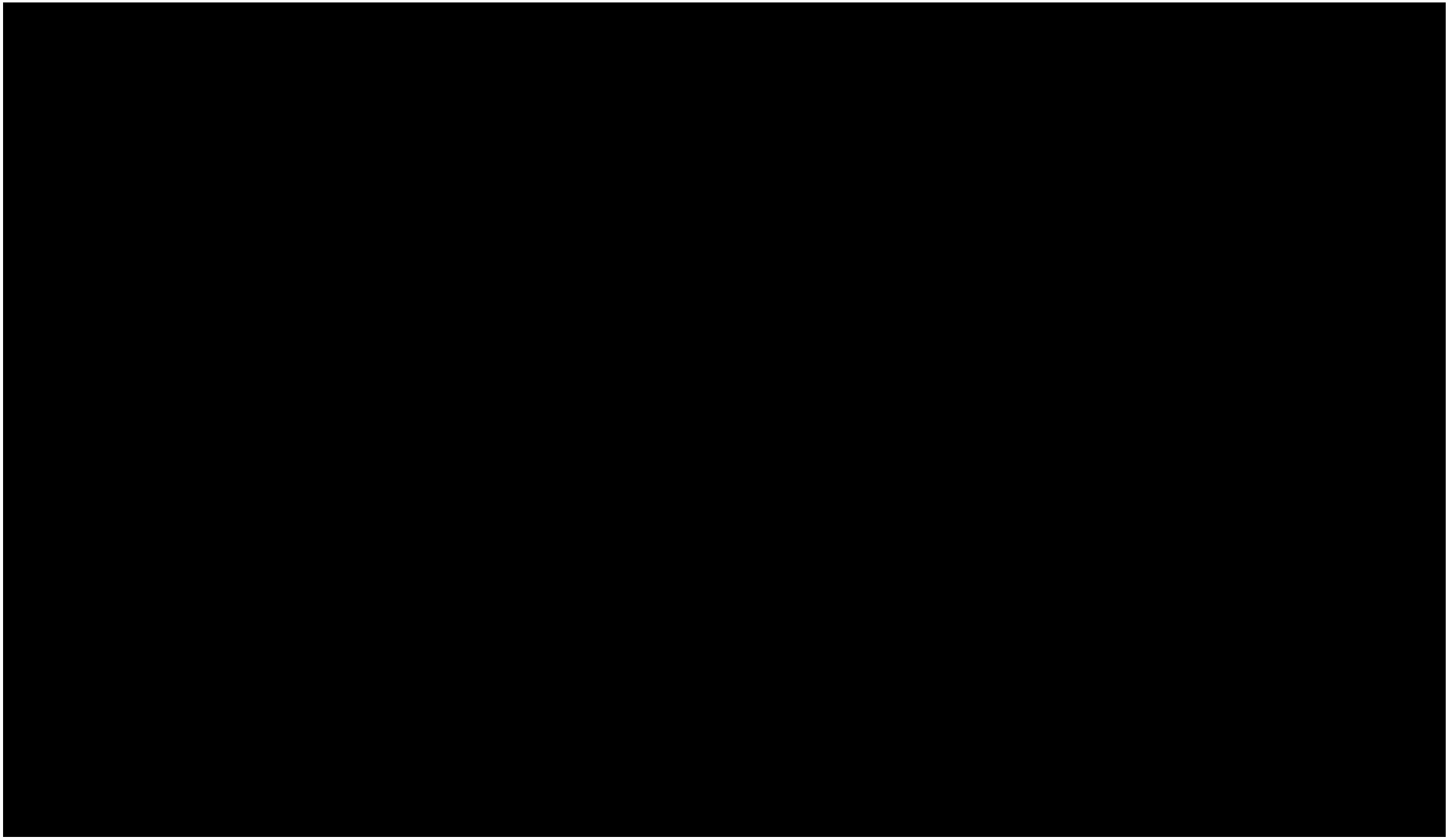




[redacted]

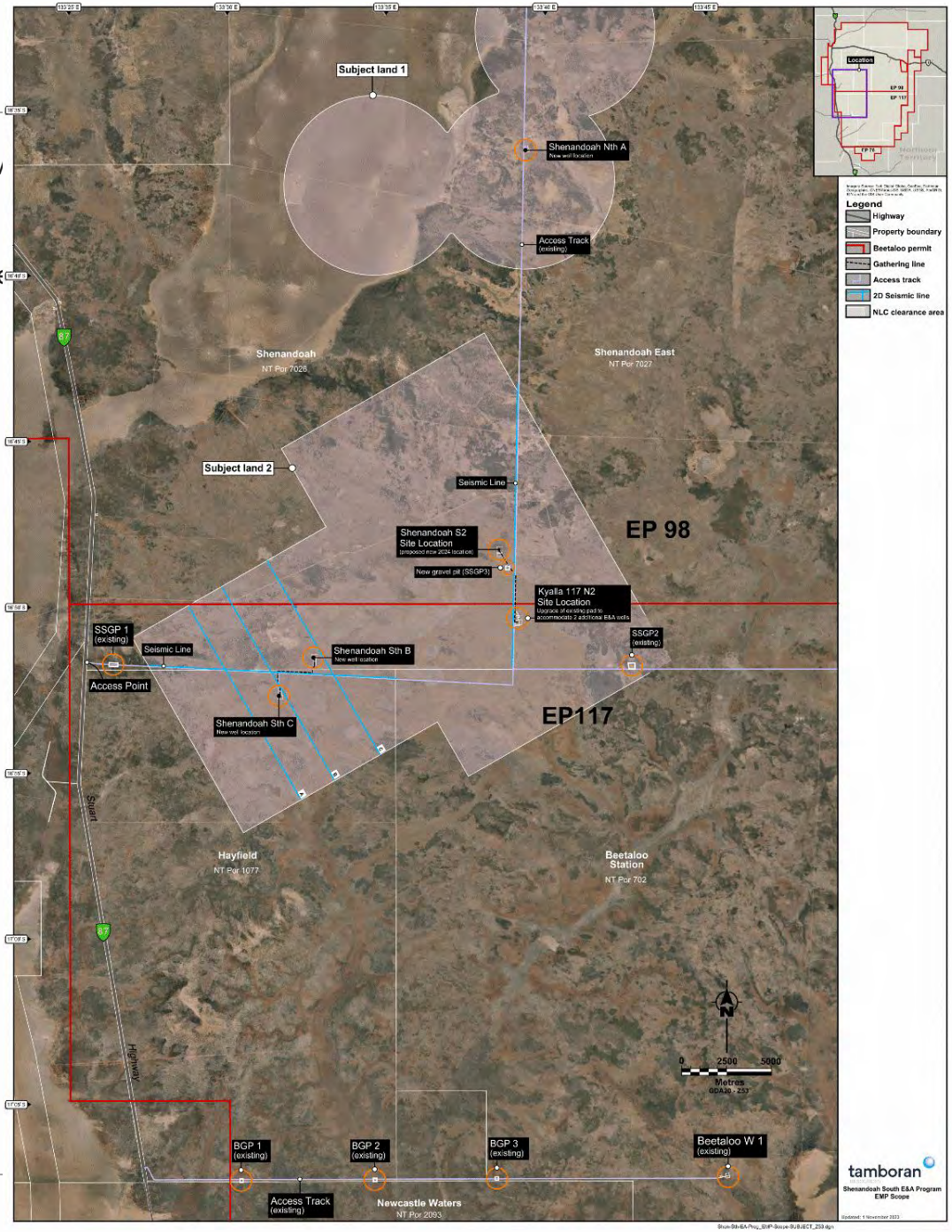
Shenandoah South E&A Program EMP

— Tamboran submitted the new Shenandoah South E&A Program Environment Management Plan (EM
the Environment Minister covering a activities around Subject land 2 (existing Kyalla 117 N2 area).

— Similar activities as previously completed, with the addition of gathering and multiple wells drilled ove
years

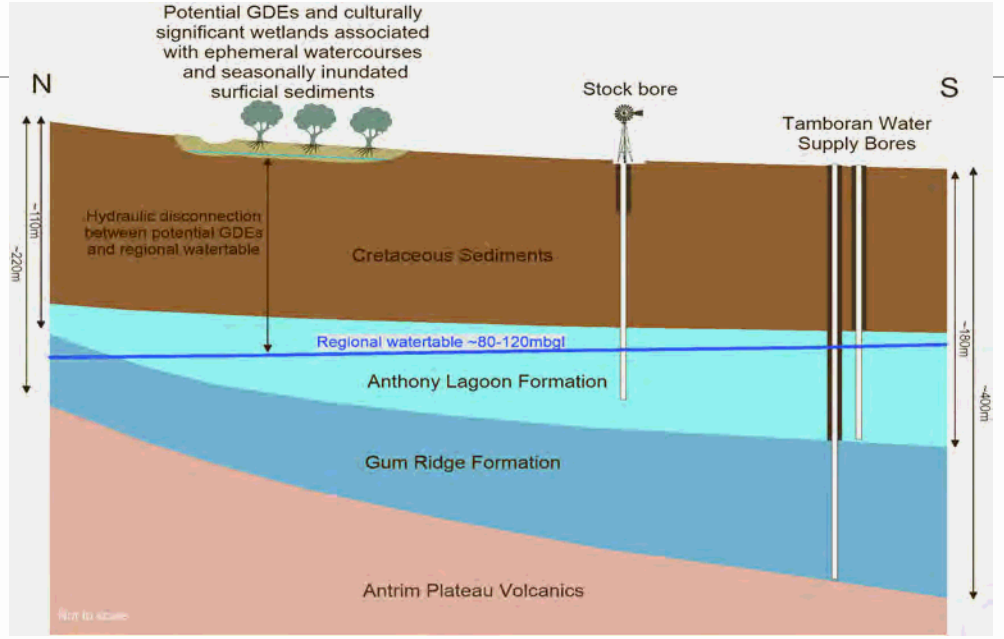
— Activities include:

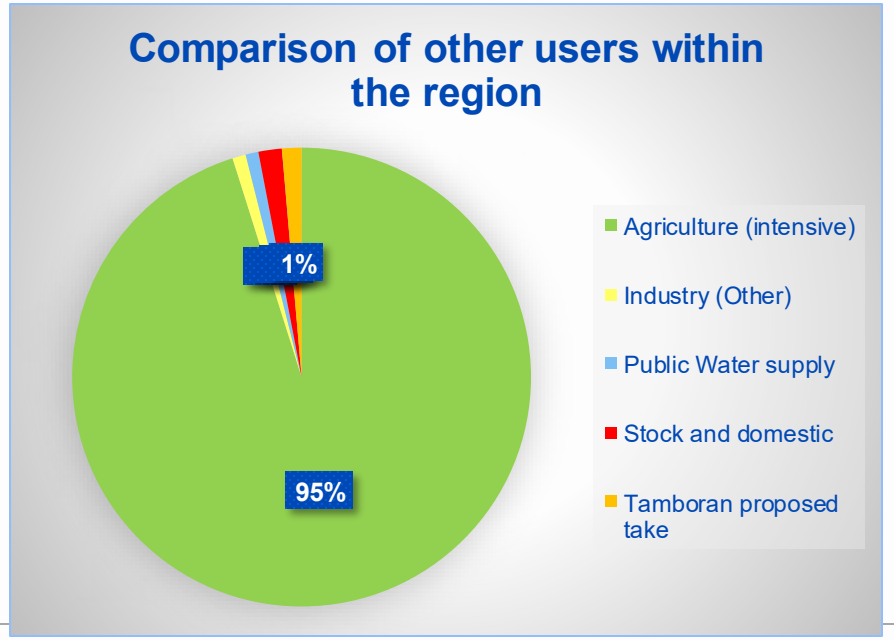
- **Subject land 2:**
  - 2D seismic program
  - Existing Kyalla 117 N2 location
  - 3 new exploration locations; Shenandoah S2,
  - Shenandoah S B and Shenandoah S C
  - drilling ,stimulation of 15 new E&A wells
  - Gathering lines connecting sites to allow for water and gas transfers
- **Subject Land 1:**
  - 1 new exploration location at Shenandoah North A (subject land 1)
- Existing Beetaloo W decommissioning (NLC cleared in 2014 and 2018)



Increased Water Extraction Licence

- Tamboran is in the process of submitting an application to increase its Water Extraction Licence from 175ML/year to 450 ML/year from the Gum Ridge Formation (GRF)
- A further 100ML/year may also be submitted in mid 2024 taking water form the Anthony Lagoon Formation
- This increased water is required to drill and test larger wells with longer horizontals
- Bigger wells reduce the number of wells we need to drill- reducing land clearing (less pads) and overall water use (less wells needed to supply same production)
- Tamboran's proposed take is minor compared to existing users and within the sustainable yield of the formation
- Water extraction to support Tamboran's exploration activities will not impact features such as water holes, creeks or Springs
- Tamboran will continue to monitor groundwater and surface water level and quality to demonstrate no harm





tamboran RESOURCES

Local employment opportunities

Since 2021, the Beetaloo Joint Venture has spent $843,000 with local Indigenous business – this excludes wages from local employees

Tamboran is focused on continuing the implementation of a range of Indigenous business opportunities covering:

- Ongoing waste management support
- Site inspection and maintenance
- Security services
- Weed monitoring and management
- Groundwater monitoring
- Equipment gas leak detection
- Field scouting and rehabilitation monitoring (Cultural managers/ tradition knowledge holders)
- Seismic node deployment

Questions?

Appendix N.1.2 29 240314 NLC comments on Tamboran's work program slides

From: Emily Beresford-Cane
To: [redacted]
Cc: [redacted]
Subject: Re: Beetaloo | NLC comments on Tamboran"s work program slides
Date: Thursday, 14 March 2024 9:08:37 PM
Attachments: image001.png
2024 03 14 Draft Tamboran 2024 NTH Work Program Presentation (NLC comments).pdf
2024.02.06 - EMP Slides - meeting with NTHs in February 2024.pdf
Photo excerpts from WP and EMP.pptx

Hi [redacted]

Thank you for your detailed comments, they are very helpful.

We will prepare a second presentation incorporating the information below for the meeting, and trust the more detailed presentation provided to the NLC will remain helpful in the NLC's ongoing consultation with Traditional Owners (prior and subsequent) to the meetings.

Look forward to seeing you in Elliott.

Thanks

Emily

On 14 Mar 2024, at 11:46 am, [redacted] wrote:

Good morning Emily

Thank you for the slide pack for the "Work Program Meeting" 19 March 2024.

We have included specific comments in the attached slide pack and general comments below.

General comments

1.1 Being clear as to the purpose of the meeting

Having looked at the slide pack and reflected on our discussions it seems that the meeting on 19 March 2024 has a few distinct elements:

- in a broader forum than the JNWG meeting the previous day, an opportunity to update the Native Title Holders on the outcomes of the exploration to date;
- the first step in the consultation process contemplated in clause 5.2(1) of the Exploration Agreements in respect of the 2024 Work Program;
- an opportunity for Tamboran to speak to the draft EMP, at Tamboran's request;
- flag a new sacred site clearance request that Tamboran is proposing to make; and
- [redacted]

We think the broader purpose of the meeting as well as distinctions between the topics need to be clear in the slide pack. You will probably need to move some of the slides around to achieve this. We also think there needs to be a new topic header slide to announce the end of one topic and the beginning of the next. These may form good break points for attendees.

1.2 NLC to interpose some commentary

Depending on how things go, it may well be appropriate for the NLC to introduce the topics to assist the Native Title Holders to understand the context and purpose of the upcoming topic from their perspective.

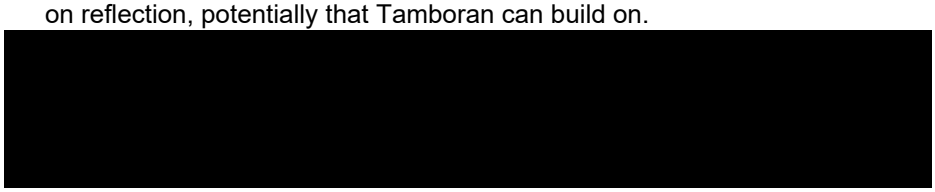
1.3 Simplification

Much of this information is pretty complex for a non-technical audience, and requires clear images and simple explanations. We have made various comments about simplifying some of the slides in point 1.7 onwards below (and in the slides themselves)

1.4 2024 Work Program/draft EMP

- We think that the 2024 Work Program description should be presented together with the corresponding environmental management measures that Tamboran are proposing in the draft EMP. The technical descriptions alone do not, for the most part, help the Native Title Holders to understand the potential impacts. Running the information together, will in our view, be valuable. So it will go: slide describing technical aspect of project (such as SS2 construction slide) followed by a slide on the impacts of construction as described in the EMP.

- In this regard you may like to see the **attached** slide deck that the NLC prepared to assist with consultation on the draft EMP. We had been initially cautious about sending this to you, but, we think it was a helpful tool and, on reflection, potentially that Tamboran can build on.



1.5 New sacred site clearance request

- This is addressed on one slide. That is a bit brief for meaningful consultation, but it is good to flag this request for additional site clearance work coming up. To allow the NLC to move this forward, we will need some additional mapping, but that will be the subject of further correspondence after next week's meeting.

- Alternatively, this may be a good opportunity to familiarise the native title holders with what you are proposing. However, this would require several more slides to more closely align with the detail you have included in section 4 of your document "2024 Work Program and Site Clearance".

1.6 Information session regarding the Appraisal Gas Agreement

- Please add slides for:
    - Purpose of the discussion
    - Information about the project (your existing slides)
    - information about the process to obtain consent - outlining the

[redacted]

- This is a point where the NLC may wish to explain that this is a session set up so Tamboran can explain what it is seeking to do, but that no decisions are being made today.

More specific slides about content (in addition to the comments in the slides)

1.7 Can Tamboran please make the slides simpler by separating out images onto separate slides where possible – in particular, the slides on the following pages: 8, 9, 10, 16, 17, 18, 25

1.8 Can Tamboran please include the **attached** photographs from the 2024 Work Program (each as a stand-alone slide). As set out above, please present on what each slide shows and the implications for NTHs.

1.9 Can Tamboran please ensure the slide pack has a slide on each of the following items (to the extent not already included in the slides):

(a) Gravel pit – dimensions, gravel extraction volume and use

(b) Access track construction – dimensions

(c) Pad land clearing – dimensions

(d) Well pad infrastructure

(e) Drill sump

(f) Gathering pipeline construction - dimensions

(g) Bulk chemical and fuel storage – types and quantities

(h) Evaporation ponds – dimensions

(i) Monitoring and extraction bores – number of bores and volume of extraction and use

(j) the irrigation of treated sewage effluent and to elaborate about this

(k) the proposed solar farm or wind turbines (referred to in the WP as a potential source of electricity generation for infrastructure);

(See **attached** "Photo excerpts from WP and EMP" for your reference.)

1.10 We think it is also likely that Tamboran may get asked questions about the recent Jemena pipeline fire in Central Queensland (which I expect may be topical among NTHs). Therefore, it would be helpful for Tamboran to address this issue proactively and explain how that situation has arisen and what measures it (or APA?) would have in place to prevent that risk from occurring in the Beetaloo.

Regards

[redacted]
Senior Lawyer (Resources & Energy)
Northern Land Council

NORTHERN LAND COUNCIL

Our Land, Our Sea, Our Life

[redacted]

[redacted] | Website: www.nlc.org.au

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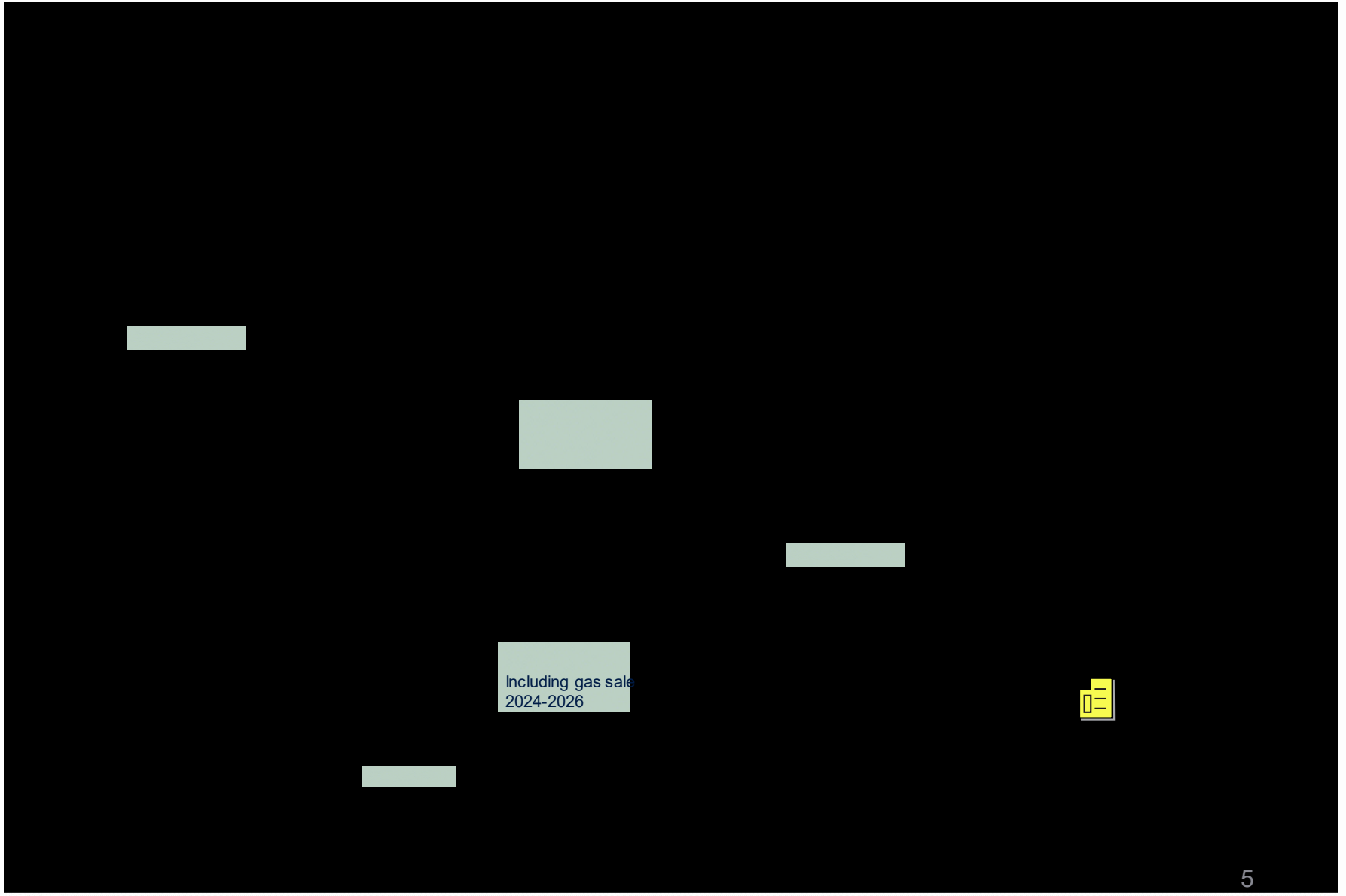
Roadmap to Production



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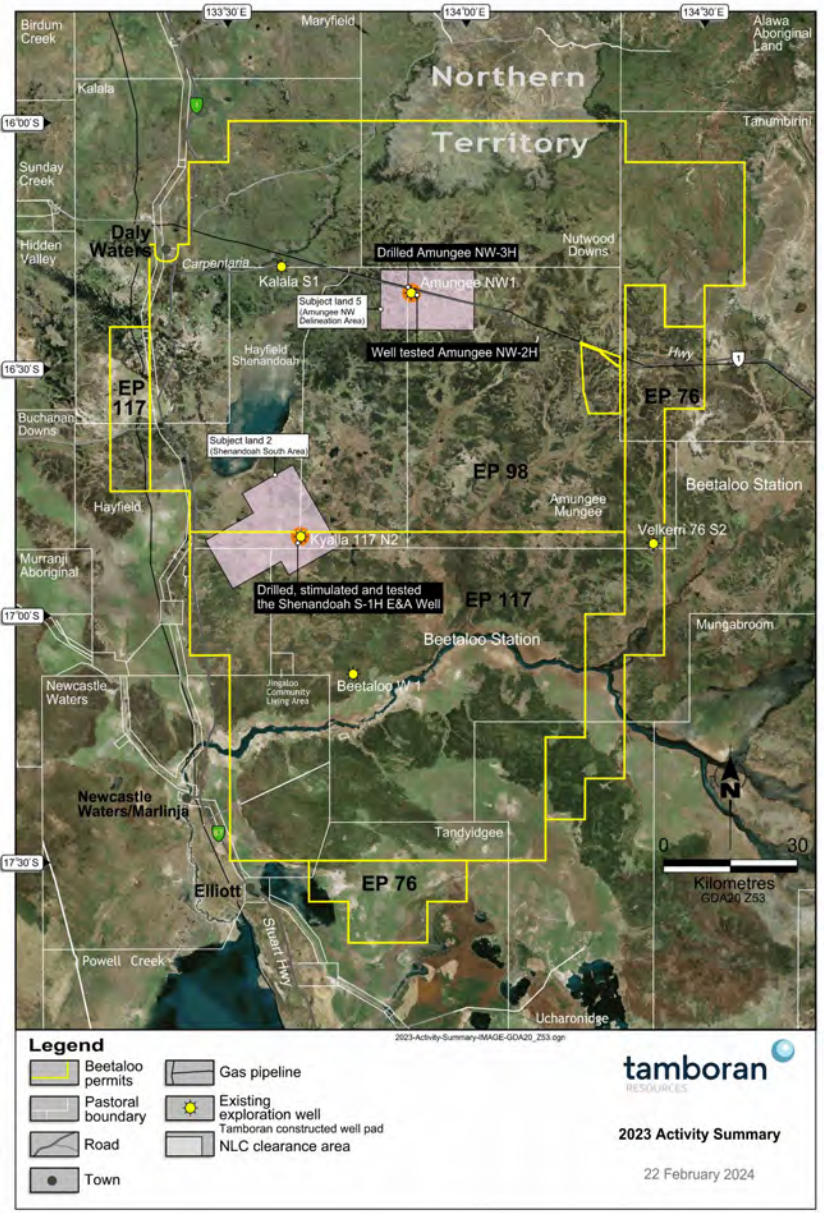

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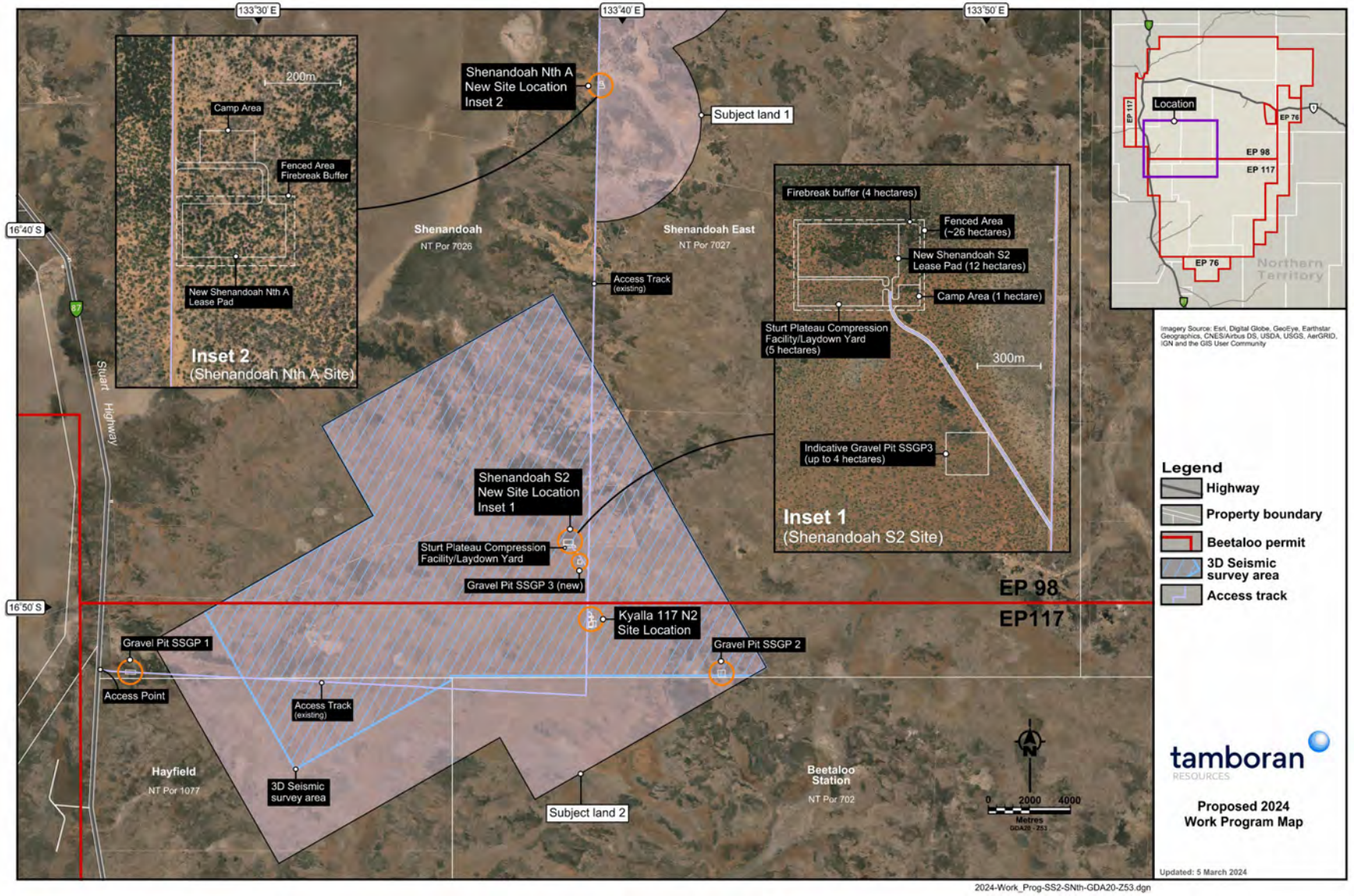

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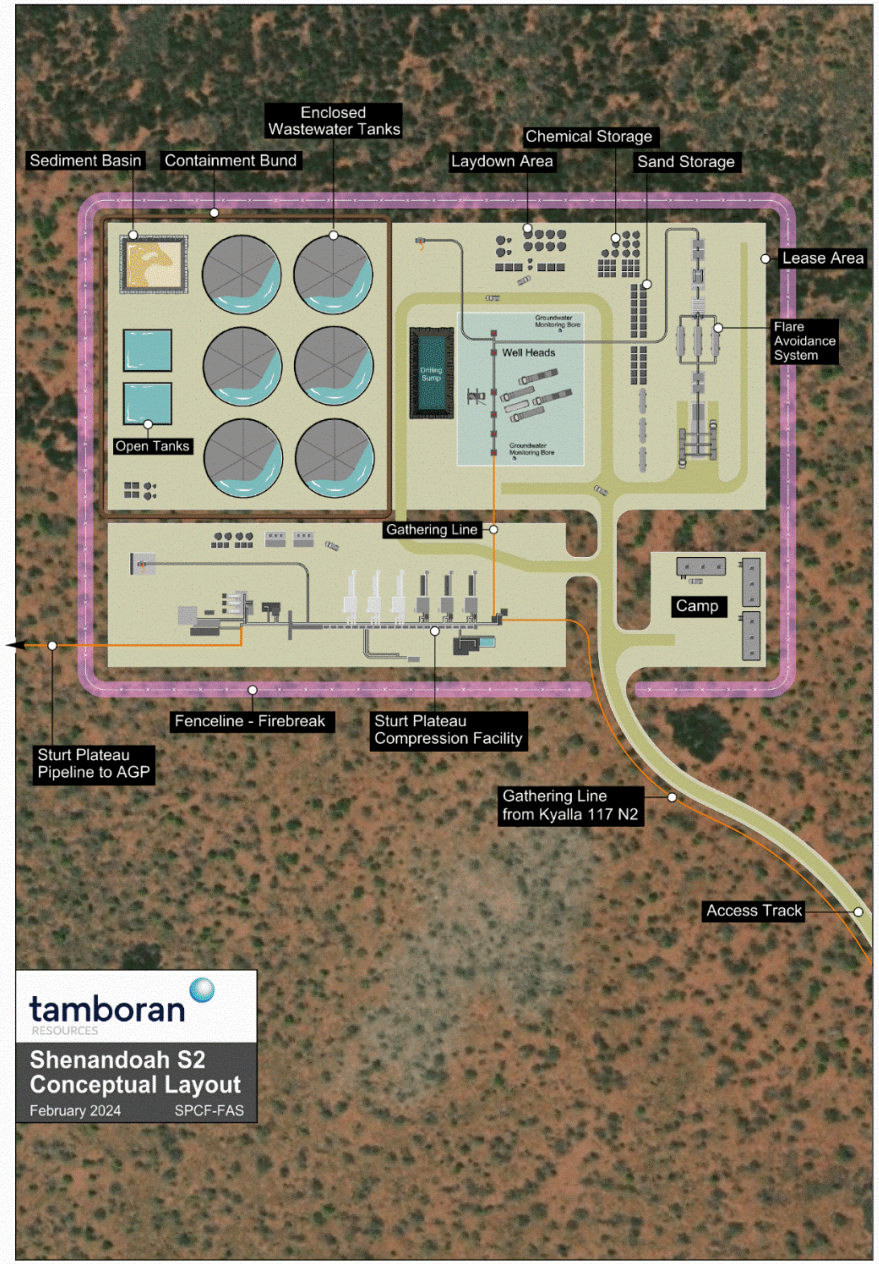

Lease pad being constructed with water bore being drilled

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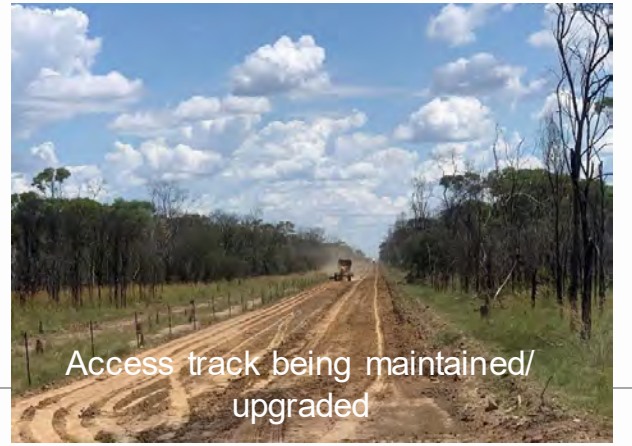
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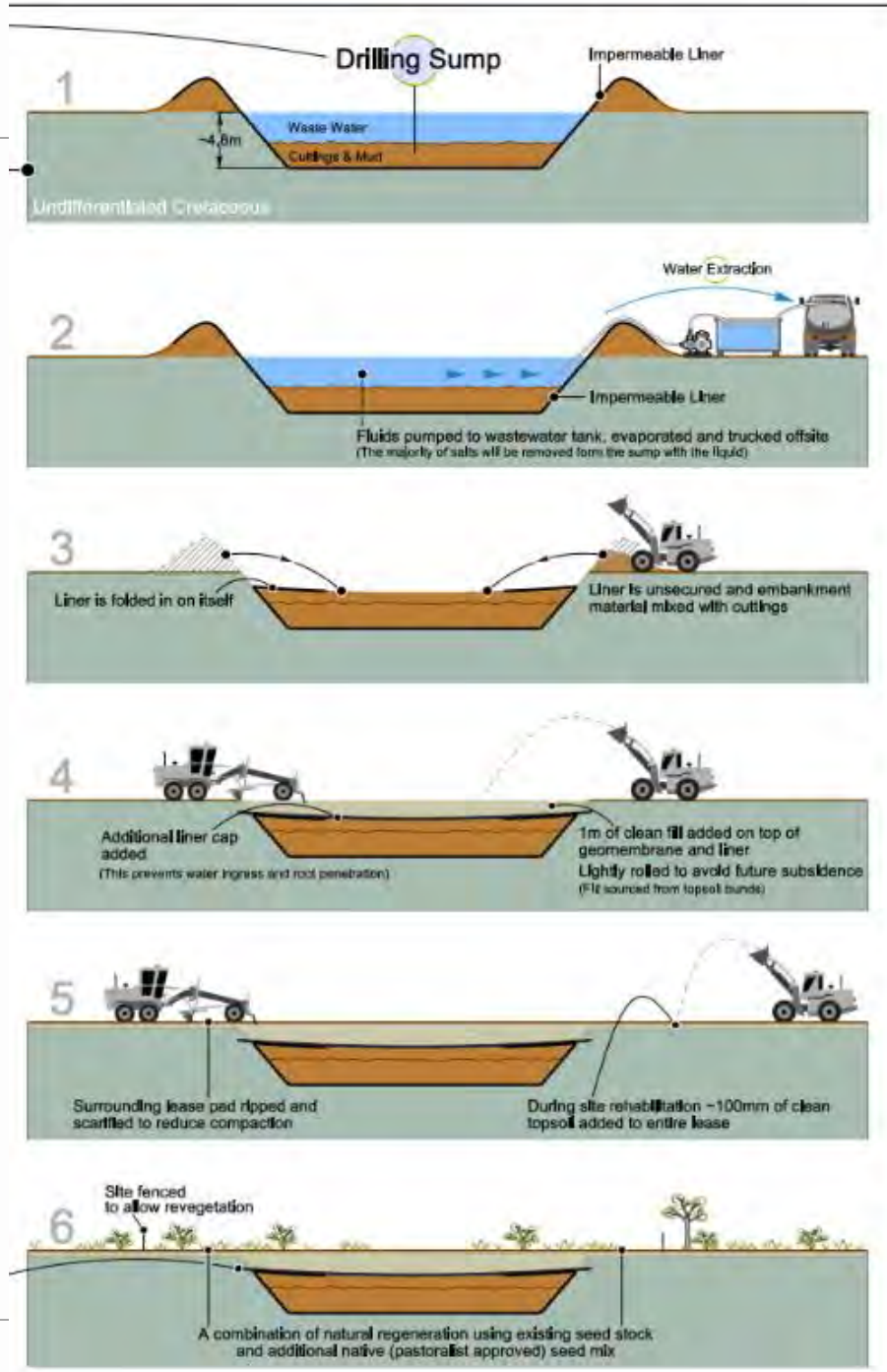
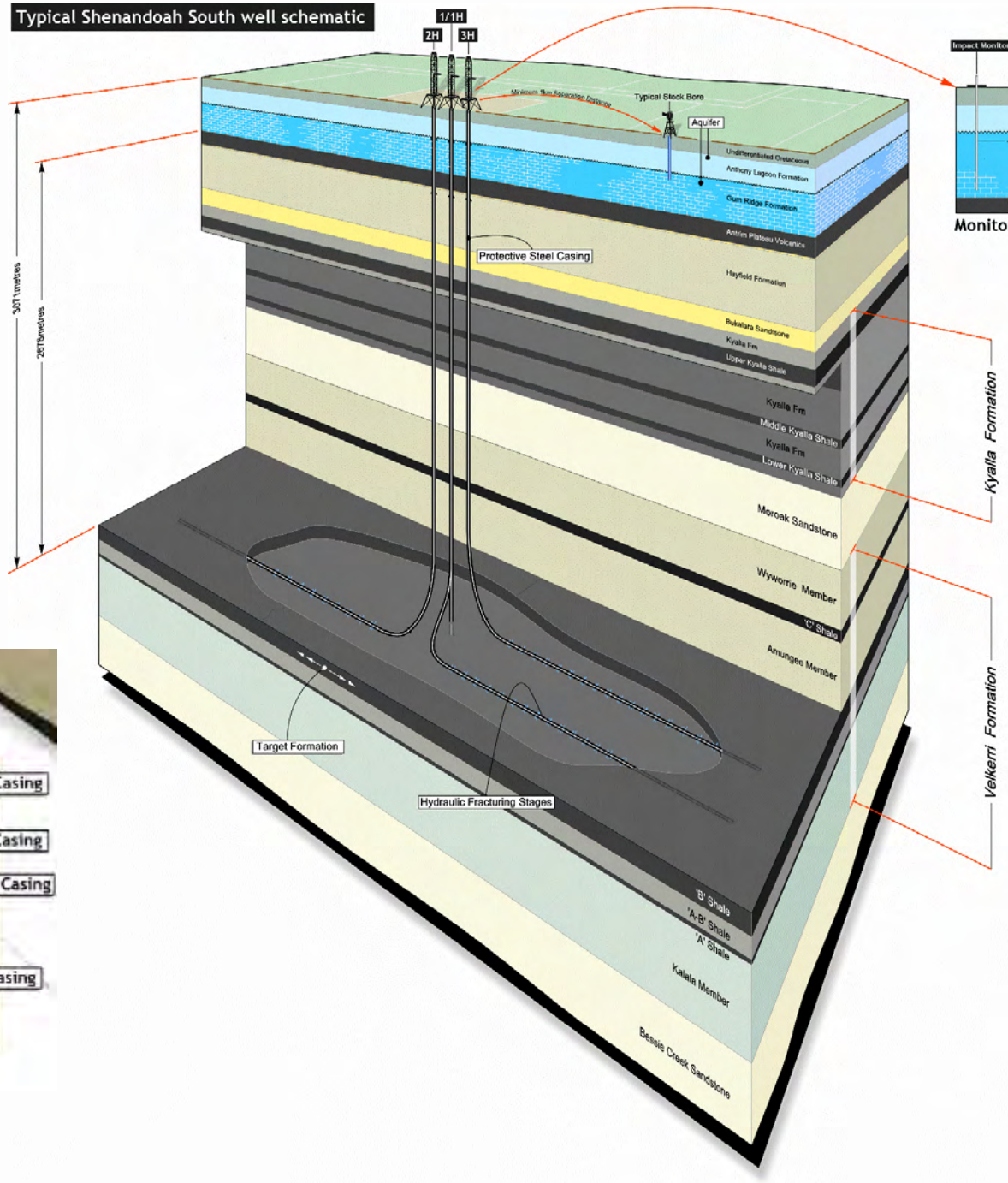
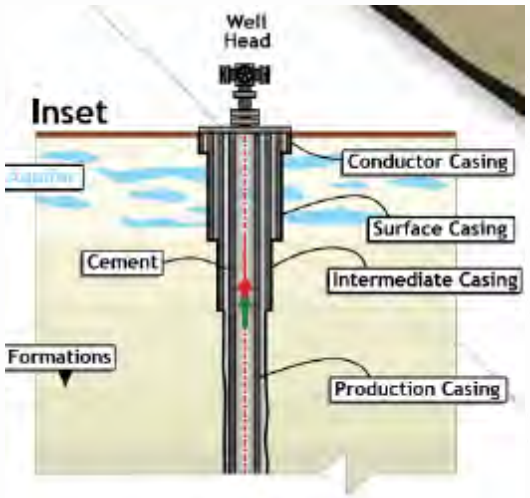


tamboran RESOURCES



Multiple string of cement and steel protect aquifers



- Typical well schematic- noting Shenandoah Nth A will not have a horizontal
- Wells targeting the Velkerri B –shale
- Approximately 3,100m below ground level
- ~2700m below the closest aquifer
- Groundwater is monitored quarterly

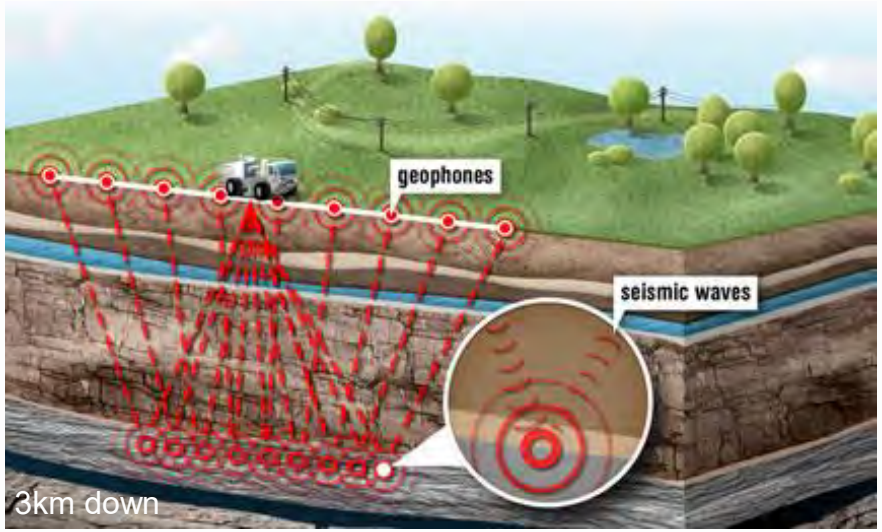
Shenandoah North A

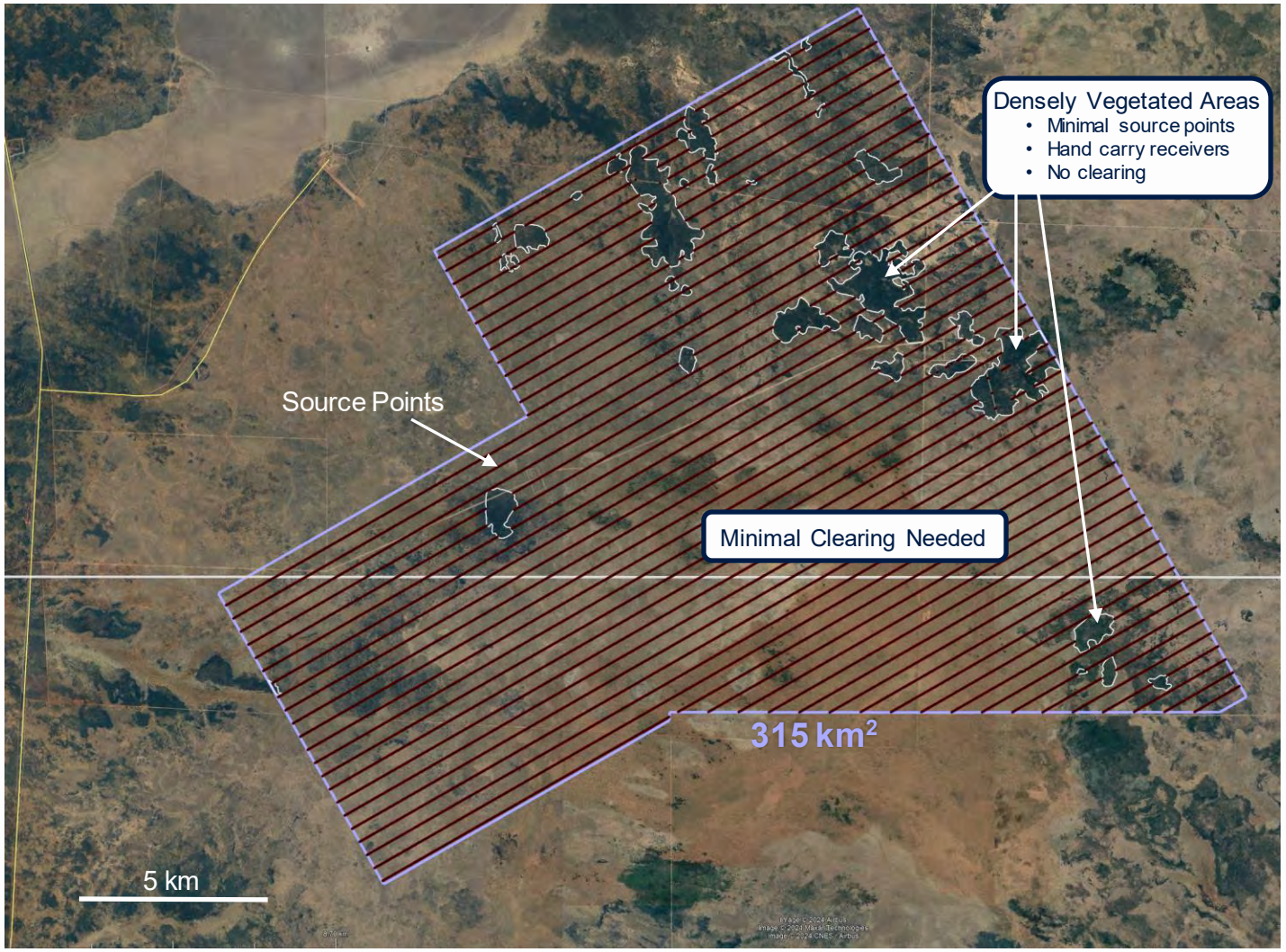
- Located within Subject Land 1
- Construction of new 3 ha Shenandoah NA including lease pad, camp pad and access tracks, land clearing and civil construction
- 2024/2025
- Drilling water bores
- Drilling of a vertical stratigraphy well
- Example provided is Amungee NW 1 being drilled

Drilling rig

Low impact 3D Seismic

- 315km^2 of low impact 3D seismic proposed for the Subject Land 2 area
- 3D seismic used to image underlying rocks to help drilling and estimate amount of gas
- The majority of lines will not be cleared
- Source and receiver lines placed around trees and vegetation to avoid clearing
- Areas of thick vegetation have source points relocated and stacked up around the edges to avoid clearing





3D Seismic - source lines

Weight drop (primary method)

- 1400kg weight dropped onto metal plate to create impulse energy.
- Can be mounted onto tractors, skid steers, posi-tracks, front end loaders, telehandlers.
- Rubber tracked carriers to remove puncture risk and create low ground pressure when travelling.

Dynamite charge

- Dynamite used where access is tight.
- Dynamite installed using a small Geotech rig 10-15m below ground.

Small rig used for dynamite charge (if required)

Use of tractors/posi-track

Small 1kg charge

Minimal disturbance-avoidance of land clearing

3D Seismic sensor deployment

- 16-20 people deploy nodes around survey area for ~6 weeks.
- Nodes listen to sound waves from energy source and record them.
- Previously used around Kyalla 117 N2 to monitor frack.
- Each node is only 150g and approx. 120mm x 40mm.
- Node is positioned into hole drilled with small hand auger ~ 60mm deep (1 small finger) x 40mm wide.
- The seismic source will start hitting the ground once enough sensors are deployed to listen.
- *****Temporary job opportunities will be available for node deployment for approximately 6 roles *****

Appraisal Gas Project

➢Longer term appraisal

- Tamboran needs to produce gas during appraisal to test the underlying shales prior to investing in a development.
- This will allow the gas to be used for power generation in NT rather than the gas being flared.
- The sale of appraisal gas will increase financial and community benefits to Native Title Holders and will also decrease greenhouse gas emissions.

➢Appraisal gas sale options

- Appraisal gas is proposed to be generated from the 2 wells drilled on Shenandoah S2 in 2024 - new wells and locations will feed into the plant in the future (2025 and 2026).
- It is proposed that a temporary compression facility and/or a compressed natural gas (CNG) facility will be constructed.
- A new pipelines (Sturt Plateau Pipeline) is also proposed to be constructed by APA.

Example of small compression facility

Flaring Gas Vs. Appraisal Gas

Appraisal gas is flared

- Gas burnt and not used or sold
- Higher greenhouse gas emissions
- No additional financial benefits to NTHs or NT
- Less job opportunities

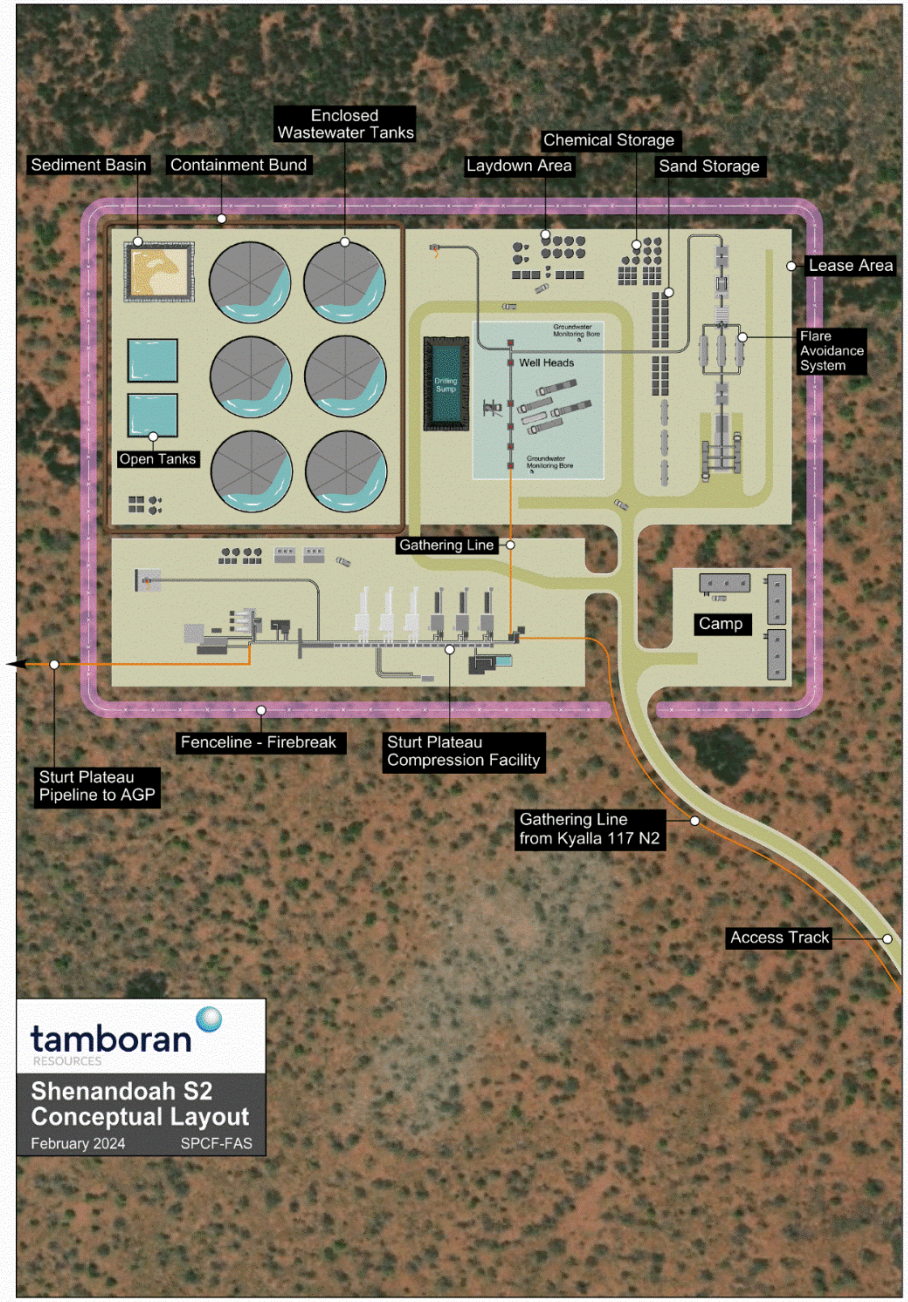
Appraisal gas is sold

- Gas is sold into the NT for electricity
- 90% less greenhouse gas emissions than flaring
- More financial benefits for NTHs
- More job opportunities in construction and operation
- Requires a slightly larger clearing area of ~6 ha to support the compression facilities

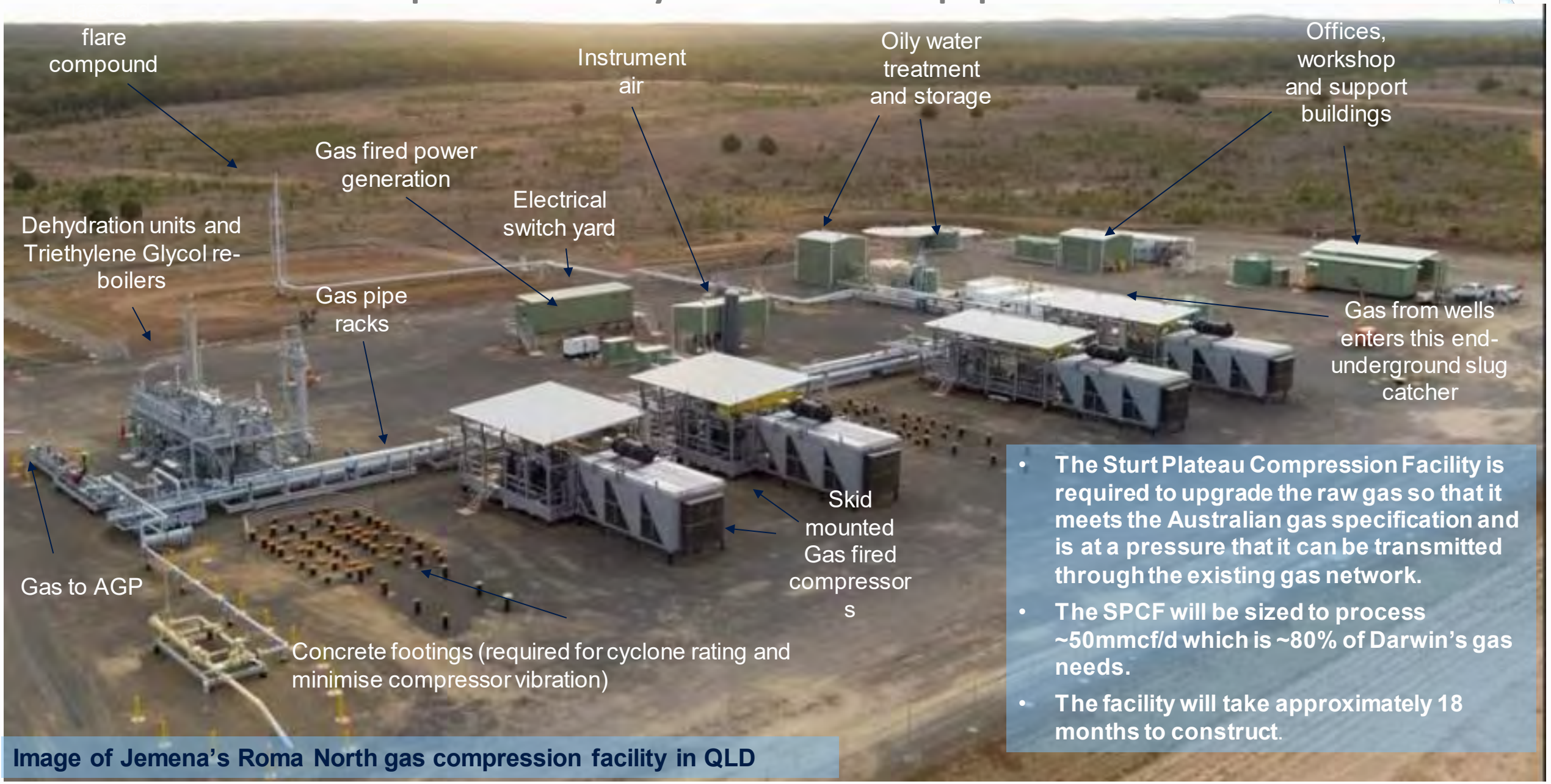
Shenandoah S2 - Appraisal Gas Project

- Sturt Plateau Compressor Facility (SPCF) and CNG facility to be located at Shenandoah S2, ~3.5Km NW of Kyalla 117 N2
- Facility will have a capacity of up to 50TJ/day
- Earthworks and footings proposed to be started in late 2024 - with compressor construction planned for 2025 dry season
- First gas proposed in Q1 2026 - with appraisal gas sold for 24-36 months
- 2-4 wells to be drilled and connected to facility each year to test new wells and locations (2024 and beyond)

Example of compressor station (flare not routine)

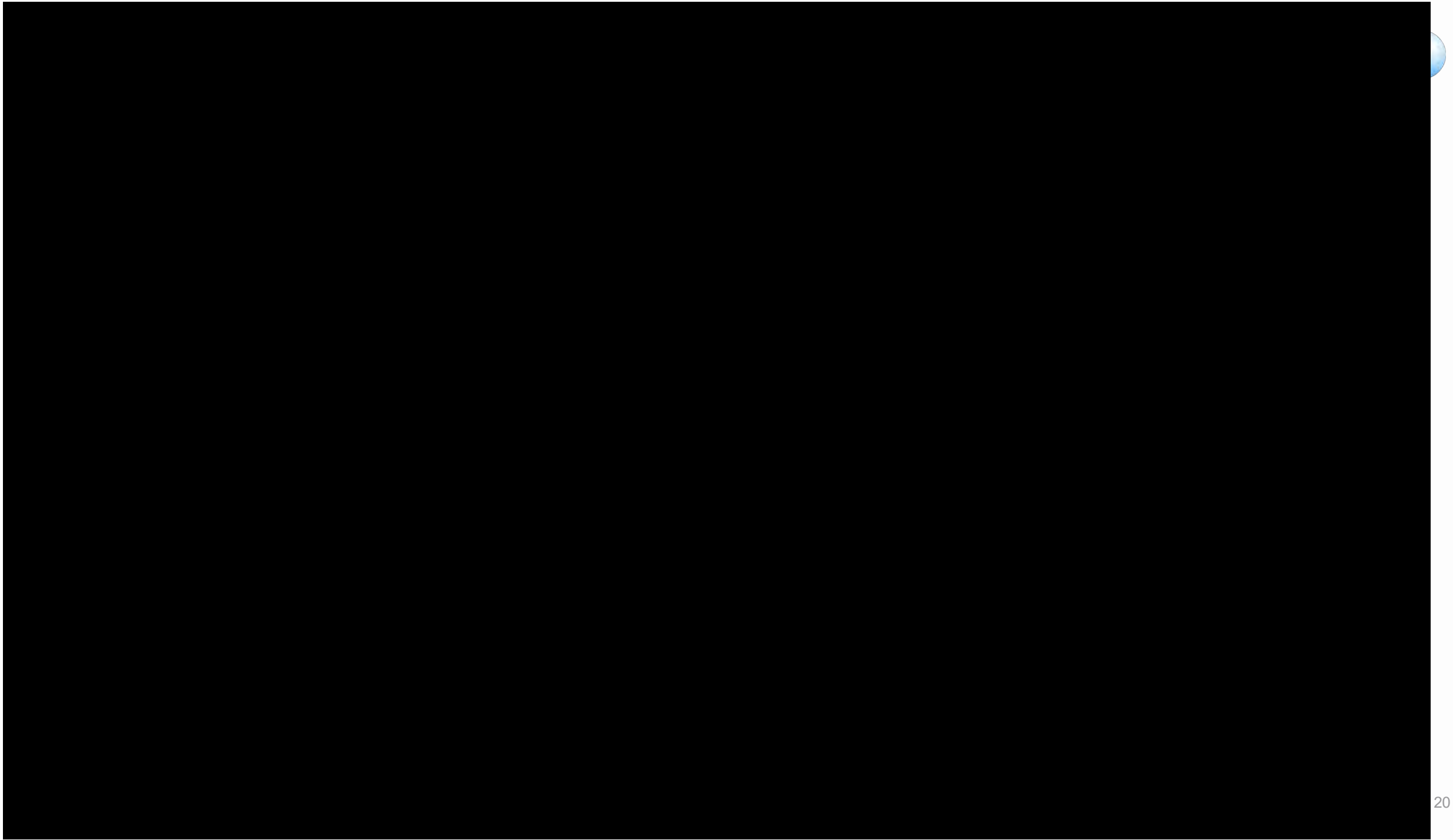


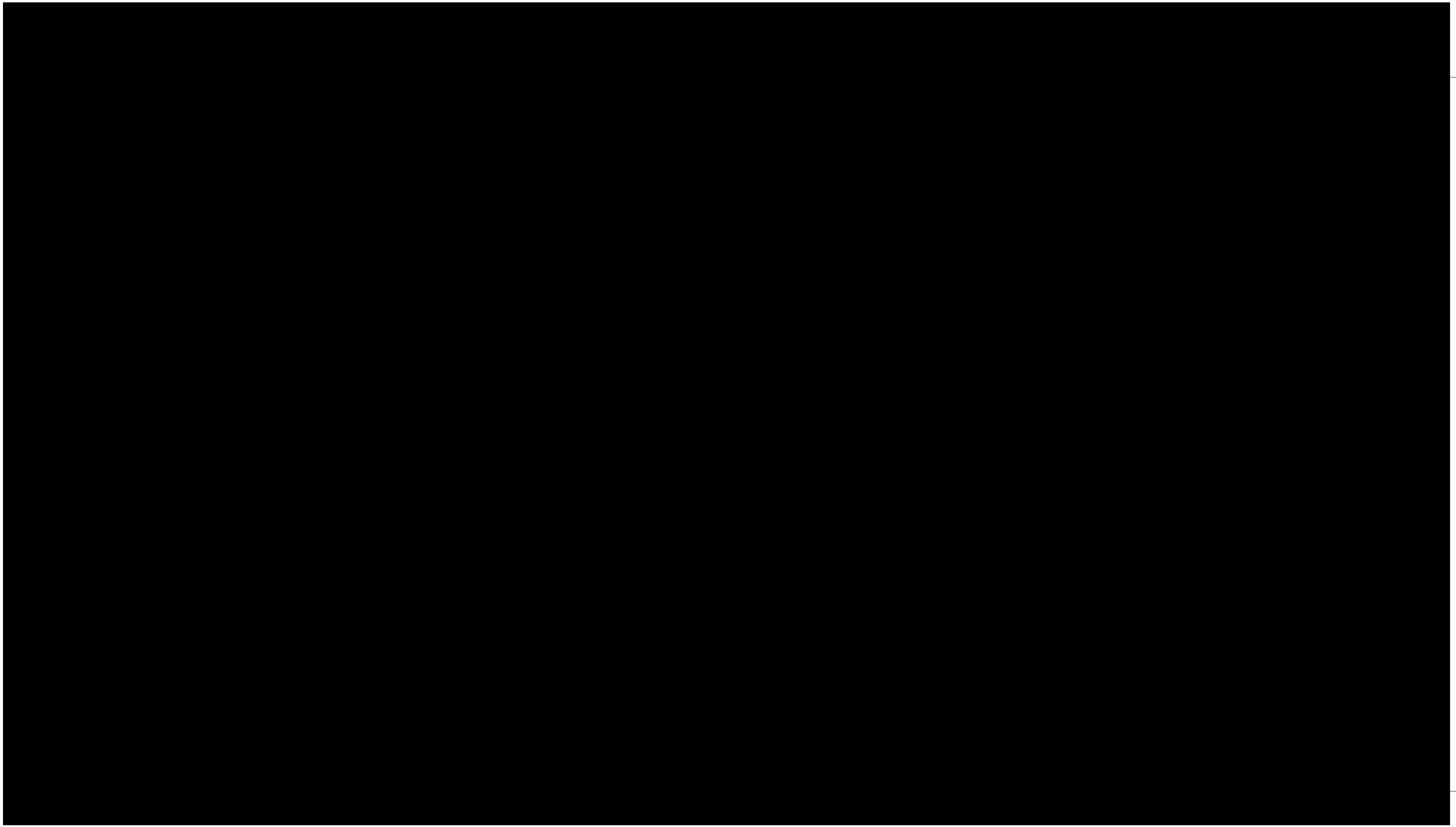
Sturt Plateau Compression Facility – overview of equipment



- **The Sturt Plateau Compression Facility is required to upgrade the raw gas so that it meets the Australian gas specification and is at a pressure that it can be transmitted through the existing gas network.**
- **The SPCF will be sized to process ~50mmcf/d which is ~80% of Darwin's gas needs.**
- **The facility will take approximately 18 months to construct.**

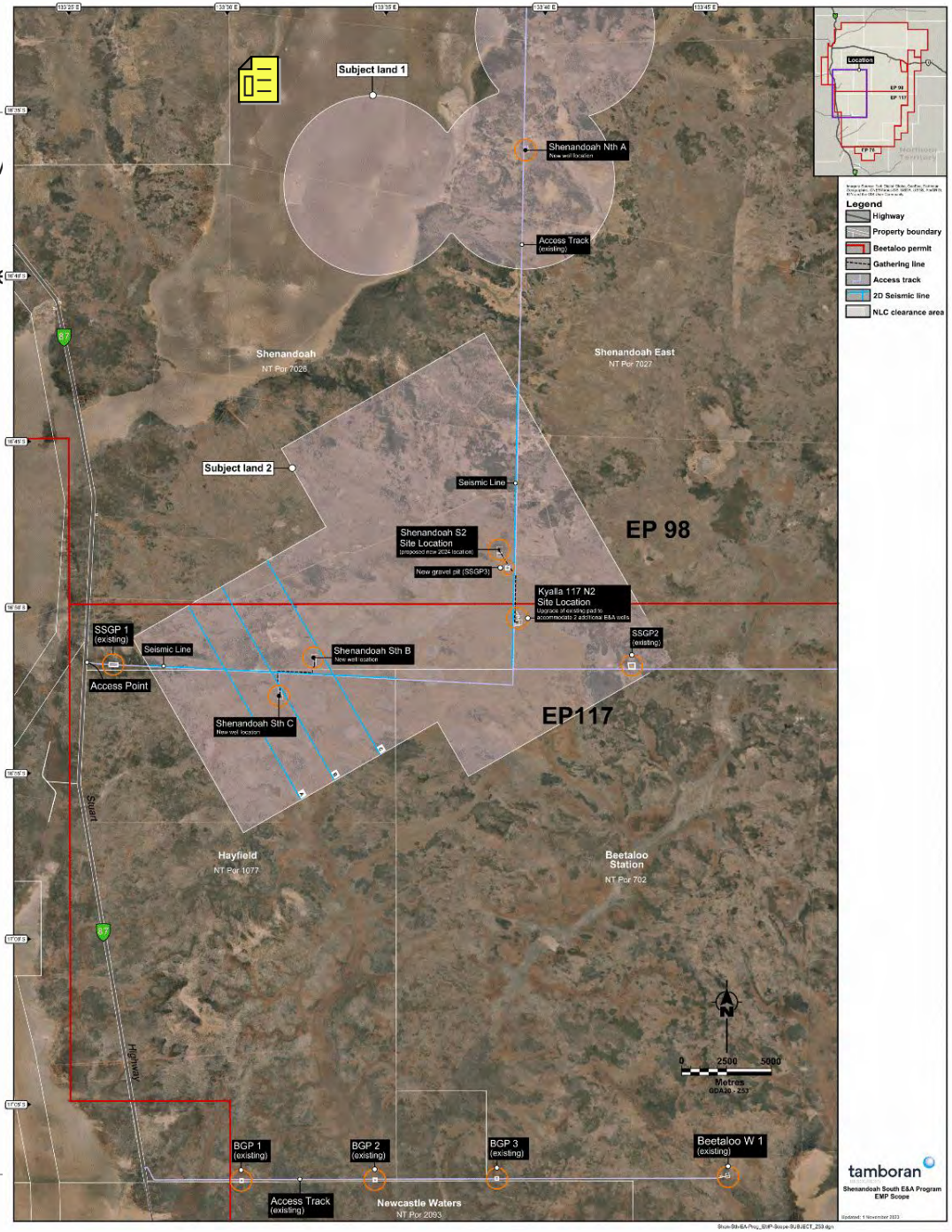
Image of Jemena's Roma North gas compression facility in QLD





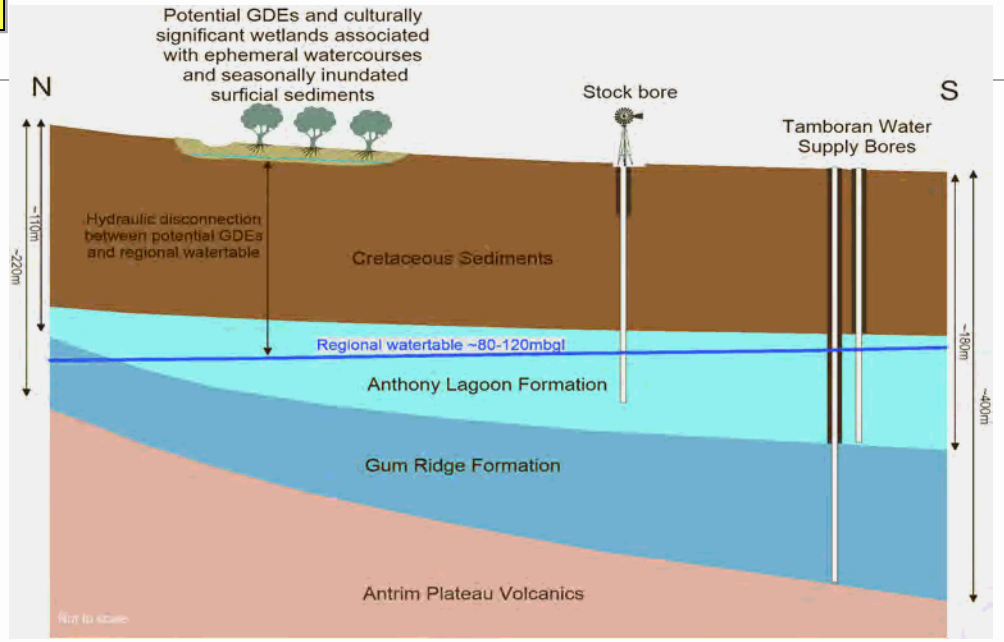
Shenandoah South E&A Program EMP

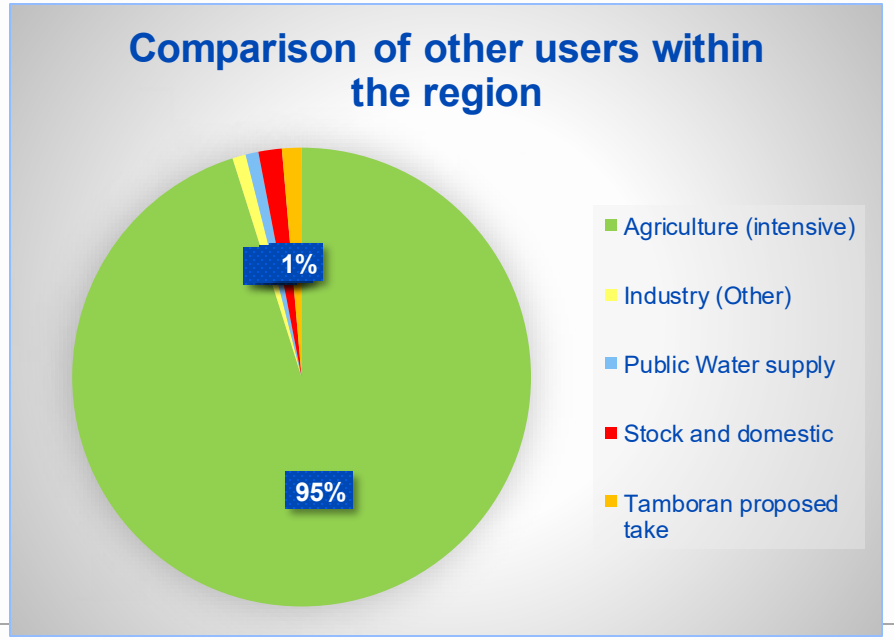
- Tamboran submitted the new Shenandoah South E&A Program Environment Management Plan (EM
  the Environment Minister covering a activities around Subject land 2 (existing Kyalla 117 N2 area).
- Similar activities as previously completed, with the addition of gathering and multiple wells drilled ove
  years
- Activities include:
  - **Subject land 2:**
    - 2D seismic program
    - Existing Kyalla 117 N2 location
    - 3 new exploration locations; Shenandoah S2,
    - Shenandoah S B and Shenandoah S C
    - drilling ,stimulation of 15 new E&A wells
    - Gathering lines connecting sites to allow for water and gas transfers
  - **Subject Land 1:**
    - 1 new exploration location at Shenandoah North A (subject land 1)
  - Existing Beetaloo W decommissioning (NLC cleared in 2014 and 2018)



Increased Water Extraction Licence

- Tamboran is in the process of submitting an application to increase its Water Extraction Licence from 175ML/year to 450 ML/year from the Gum Ridge Formation (GRF)
- A further 100ML/year may also be submitted in mid 2024 taking water form the Anthony Lagoon Formation
- This increased water is required to drill and test larger wells with longer horizontals
- Bigger wells reduce the number of wells we need to drill- reducing land clearing (less pads) and overall water use (less wells needed to supply same production)
- Tamboran's proposed take is minor compared to existing users and within the sustainable yield of the formation
- Water extraction to support Tamboran's exploration activities will not impact features such as water holes, creeks or Springs
- Tamboran will continue to monitor groundwater and surface water level and quality to demonstrate no harm





tamboran RESOURCES

Questions?

Gravel pit – gravel extraction and use

Access track construction